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Linear Multivariable Regression Models for Prediction of Eddy Dissipation Rate from Available Meteorological Data

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July 2005

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Abstract

Linear multivariable regression models for predicting day and night Eddy Dissipation Rate (EDR) from available meteorological data sources are defined and validated. Model definition is based on a combination of 1997-2000 Dallas/Fort Worth (DFW) data sources, EDR from Aircraft Vortex Spacing System (AVOSS) deployment data, and regression variables primarily from corresponding Automated Surface Observation System (ASOS) data. Model validation is accomplished through EDR predictions on a similar combination of 1994-1995 Memphis (MEM) AVOSS and ASOS data, supplemented with testing using complementary DFW data train and test subsets. Model forms include an intercept plus a single term of fixed optimal power for each of these regression variables; 30-minute forward averaged mean and variance of near-surface wind speed and temperature, variance of wind direction, and a discrete cloud cover metric. Optimal powers are determined by maximizing explained variation during single variable least squares regression. Intercept and term coefficients are then determined by multivariable least squares regression using wind speed variance weighting. Distinct day and night models, regressing on EDR and the natural log of EDR respectively, yield best performance and avoid model discontinuity over day/night data boundaries. Existing AVOSS vortex prediction algorithms may use model predicted EDR from airport specific ASOS data to generate local weather dependent estimates of aircraft wake vortex transport and decay to assess the performance of future wake spacing system concepts. Model-ready, full-year 1999 ASOS data for DFW and 11 additional airport sites is prepared for this purpose.

Introduction

In response to the recognized approaching capacity crisis of the national airspace system, NASA is addressing airport capacity enhancements previously through the Terminal Area Productivity (TAP) program and currently through the Virtual Airspace Modeling and Simulation (VAMS) project. Within TAP, the Reduced Spacing Operations element at Langley developed technologies for an Aircraft VOrtex Spacing System (AVOSS), which integrates the output of several systems to provide weather-dependent wake vortex spacing criteria for maximizing airport capacity while maintaining safety [1]. Initial pre-AVOSS deployments occurred in 1994 and 1995 at the Memphis International Airport (MEM). Following the 1997 deployment of a first generation AVOSS at the Dallas-Fort Worth International Airport (DFW) [2] and follow-up testing in 1998, a successful real-time demonstration at that location in 2000 of a second generation AVOSS, including advances in wake vortex prediction, produced AVOSS dynamic spacing representing a 6% gain in average airport throughput over current Federal Aviation Administration (FAA) fixed (worst case) separation criteria, which translates to 15-40% reductions in delay when applied to realistic capacity ratios at major airports [3]. The VAMS project is investigating numerous en route and terminal capacity-increasing concepts and developing tools for evaluation of these concepts. The work described in this report supports the VAMS project by providing data that can be used for wake spacing concept benefits analysis.

A parallel Langley effort is the development of an online AVOSS data warehouse system to support follow-on to AVOSS work by individual researchers and focused programs. This report documents three facets of that development; 1) the generation of AVOSS deployment based representative weather profile data sets, including measured Eddy Dissipation Rate (EDR), for testing future implementations of the AVOSS wake vortex prediction capability, 2) the development of linear multivariable regression models for the prediction of EDR data from available meteorological data sources such as the Automated Surface Observation System (ASOS), and 3) the preparation of model-ready, full-year 1999 ASOS data sets for DFW and 11 additional airport sites. The EDR prediction model definitions are trained on AVOSS DFW

deployment data and evaluated against AVOSS MEM deployment data. The full-year 1999 ASOS based data sets for DFW and the 11 additional airport sites can then be supplemented with model defined EDR data, allowing a further evaluation of model suitability as an EDR data source for wake vortex prediction over a wide range of sites.

Background AVOSS information establishing the need for an EDR prediction model and identifying basic model requirements and the approach leading to their development are discussed in the remaining parts of this section. Detailed descriptions of data collection and preparation, data sets comparison, and model development, evaluation, selection, and validation are provided in later sections. Requirements for generated data sets are included in the data collection and preparation section. Summary and conclusion sections complete the body of the report. Appendices and figures provide supporting information.

Background

AVOSS employs a wake vortex prediction algorithm that estimates a time history of wingtip vortex positions and strength. Principal inputs to this algorithm are wind, temperature, and turbulence within the planetary boundary layer. Early versions of the algorithm estimated turbulence intensity from Turbulent Kinetic Energy (TKE). The development of Version 3, and its AVOSS demonstration variant, Version 3.1.1 [4], substituted EDR for TKE as an improved estimator of turbulence intensity and predictor of vortex decay, given its reduced sensitivity to measurement time scale and increased amenability to extrapolation to altitudes above the sensors [1]. Redundant methods of calculating EDR, including vertical profiles based on two-level meteorological tower measurements during AVOSS deployment [5] and resolved winds from a mesoscale atmospheric model [6] provide for increased AVOSS robustness and opportunity for verification. Direct prediction of EDR from ASOS data represents yet another potential method, which relies only on existing and widely available data sources. The prepared linear multivariable regression models and supporting full year 1999 ASOS based data sets for DFW and the 11 sites where AVOSS has not been deployed provide a means of assessing the effectiveness of this method and its potential dependency on site specific models.

Requirement

EDR values typically range over several orders of magnitude and, for an initial feasibility assessment of regression model prediction accuracy in support of the Wake Vortex Advisory System (WakeVAS), need only be predicted to the correct order of magnitude. The regression model must, however, satisfy this requirement for all hours of the day and all seasons of the year within the climes of the continental U. S. Satisfactory predictions may involve a low value bias in predicted EDR, since the slower vortex decay rates they help predict produce conservative higher predicted vortex strength values. However, a high value bias in predicted EDR is to be avoided.

A chosen restriction, for application to WakeVAS, is that the model must be linear in form, and the result of multivariable regression on all selected regression variables; independent correlations between subsets of these variables are not desired. Furthermore, the data set used to estimate parameters in the model is to be taken from a prepared DFW representative weather profile data set representing 30-minute forward averaged mean and variance representations of raw data collected during 1997-2000 DFW AVOSS deployments, with variables in the following list considered for selection as regression variables:

- Mean and variance wind speed (m/s) and direction (magnetic).
- Mean and variance of the temperature and dew point (degrees C).
- Sky conditions (as defined in the METAR aviation weather report).
- Visibility and weather conditions.
- Time (UTC), day/night status (local), and date.

While a single model is envisioned, a maximum of two models, applicable to mutually exclusive domain, are acceptable provided superior predictions can be achieved. Separate day and night models are an example. Validation of the developed model(s) is to be determined primarily by comparison of model EDR predictions to reported 1994-1995 MEM AVOSS deployment EDR values, where the models are based on data points of this MEM data set which fully define all regression variable values used by the models. This comparison will be supported by a MEM representative weather profile data set prepared, like its DFW counterpart, with 30-minute forward averaged mean and variance representations of raw data. As detailed later in the section addressing data collection and preparation, both DFW and MEM AVOSS deployment data contain EDR values representing 30-minute forward averages based on higher frequency raw sensor data.

Model validation is to be supplemented by intra-DFW data evaluation, which estimates parameters and tests EDR prediction models on complementary (and thus mutually exclusive) subsets of the DFW data. These subsets are to be selected in a manner that retains in each a good representation of the entire data set. Such testing will minimize model prediction errors arising from estimation and test sets of different character, and is expected to help identify any inherent model weaknesses such as over estimation. A subsequent comparison of model performance assessment based on intra-DFW data evaluation with that achieved when the estimation and testing data sets are known to be dissimilar in character, as is the case with DFW data based training and MEM data based testing, may provide insight into model robustness and generality.

Approach

The basic approach to model development and evaluation is governed by the above requirements. Specific techniques for meeting these requirements were selected from accepted statistical and computational practices, and modified or refined during the development and evaluation process. An overview is presented here, with further detail deferred until later sections.

A preliminary assessment of the characteristics of the DFW and MEM data sets and their differences is performed. This is primarily accomplished through comparisons of EDR and candidate regression variable distributions. Given the known existence of a nighttime low altitude jet in the DFW vicinity, particular attention is given to differences in time of day distributions. Some differences in site data sources are also identified.

Several candidate model forms are considered. These model forms typically consist of the sum of an intercept plus single terms of fixed optimal power for each regression variable selected. Model definition, or model parameters estimation, is the result of fixing model form intercept, term coefficients, and term powers by least squares regression on filtered DFW data, our selected estimation data set. Data filtering removes from consideration all data points that are not applicable, are considered outliers, or define an insufficient or physically non-meaningful subset of variables. Outliers are determined through application of informal criteria and visual inspection.

Analysis of variance (ANOVA) on single variable regressions of EDR or ln(EDR), the natural log of EDR, over each candidate regression variable are initially used to select regression variables and determine their optimal term powers, while corresponding multivariable regressions are used to complete EDR or ln(EDR) model definitions by determining intercept and term coefficient values. Optimal powers are determined on the basis of maximum explained variation. Alternative regression weightings are attempted during both of these model definition phases. Separate day and night specific models are

considered as alternatives to a single 24-hour model. Visual Numerics® PV-WAVE® statistics software routines are used to perform the regressions [7].

Model selection and validation is primarily based on a statistical evaluation of their ability to predict EDR when applied to similarly filtered MEM test data. This evaluation is made with respect to a vector of normalized model EDR over-prediction error (model minus data) over all data points of the MEM test set, where normalization is with respect to data point EDR. The primary evaluation statistics are the mean and standard deviation of model error, which respectively represent model bias and goodness of fit. Model error distribution as a function of EDR, and plots of model fit and error over test data points provide additional insight.

Model validation is supplemented with similar evaluations of intra-DFW models of identical form, but defined on and applied to complementary (and mutually exclusive) parameter estimation and test portions of the applicable filtered DFW data sets. For a given model form, three nearly equal sized partitions of the applicable portion of the data set are formed in a manner that retains similar data point characteristics in each. All combinations of two partitions are then used as model estimation data sets, and the resulting model is then applied to the remaining partition serving as the test data set. The predictive performance of the resulting three models is compared, and their average performance then compared with that achieved by the full DFW data set defined model when applied to the MEM data set. The former comparison provides an opportunity to gauge the sensitivity of the model parameter estimation process, while the latter comparison provides a means of assessing the impact of model training and prediction on data sets of different character. A final comparison of intra-DFW model fit error and prediction error provides a means of assessing any model over-fitting.

Target Application

The initial target application for the developed model is EDR prediction from ASOS data for DFW and eleven additional airports for the entire year 1999. Results of this application will support benefits analysis of WakeVAS concepts by providing meteorological input data for locations where field data has not been collected. Data collection and preparation has been completed, and is expected to support a future pursuit of the target application.

Symbols

Acronyms

ANOVA	Analysis of variance
ASOS	Automated Surface Observation System
AVOSS	Aircraft VOrtex Spacing System
CSV	Comma Separated Variable
DFW	Dallas/Fort Worth International Airport
EDR	Eddy Dissipation Rate
FAA	Federal Aviation Administration
IDX	Index of regression variable in selected set of six
MEM	Memphis International Airport (MemTow also used in plots)
METAR	Meteorological Aviation Routine Weather
NASA	National Aeronautics and Space Administration
NBR	Number of regression variables represented in model
TAP	Terminal Area Productivity
TKE	Turbulent Kinetic Energy
UTC	Coordinated Universal Time (formerly Greenwich Mean Time - GMT)

Data Partitions

DFW_d	Day only subset of DFW (defined by dn = 1)
DFW_n	Night only subset of DFW (defined by dn = 0)
DFW_{di}	Partition i of DFW_d, i = 1, 2, or 3
DFW_d^{i}	Complement, within DFW_d, of partition i of DFW_d, i = 1, 2, or 3
DFW_{ni}	Partition i of DFW_n, i = 1, 2, or 3
DFW_n^{i}	Complement, within DFW_n, of partition i of DFW_n, i = 1, 2, or 3
MEM_d	Day only subset of MEM (defined by dn = 1)
MEM_n	Night only subset of MEM (defined by dn = 0)

Data and Related Variables

EDR	Eddy Dissipation Rate
ln(EDR)	Natural logarithm of EDR
$EDR^{\sim}$	Model predicted EDR
cld_cvr (cc)	Cloud cover
dewpt (dp)	Dew point
dewpt_var (dpv)	Dew point variance
dn	Day/Night indicator
temp (tp)	Temperature
temp_var (tpv)	Temperature variance
wind_dir (wd)	Wind direction
wind_dir_var (wdv)	Wind direction variance
wind_spd (ws)	Wind speed
wind_spd_var (wsv)	Wind speed variance

Models

Model Types

M_u	Uniform weighting on EDR
M_{ws}	Wind speed weighting on EDR
M_{wsv}	Wind speed variance weighting on EDR
lnM_{wsv}	Wind speed variance weighting on ln(EDR)

Principal Candidates

M_u[DFW:all]	6-variable, uniform weighted, on 24-hour DFW EDR
M_{wsv}[DFW:all]	6-variable, wind_spd_var weighted, on 24-hour DFW EDR
M_{ws}[DFW:all]	6-variable, wind_spd weighted, on 24-hour DFW EDR
lnM_{wsv}[DFW:all]	6-variable, wind_spd_var weighted, on 24-hour DFW ln(EDR)
M_u[DFW_d:all]	6-variable, uniform weighted, on day only DFW EDR
M_{wsv}[DFW_d:all]	6-variable, wind_spd_var weighted, on day only DFW EDR
M_{ws}[DFW_d:all]	6-variable, wind_spd weighted, on day only DFW EDR
lnM_{wsv}[DFW_d:all]	6-variable, wind_spd_var weighted, on day only DFW ln(EDR)
M_u[DFW_n:all]	6-variable, uniform weighted, on night only DFW EDR
M_{wsv}[DFW_n:all]	6-variable, wind_spd_var weighted, on night only DFW EDR
M_{ws}[DFW_n:all]	6-variable, wind_spd weighted, on night only DFW EDR
lnM_{wsv}[DFW_n:all]	6-variable, wind_spd_var weighted, on night only DFW ln(EDR)

Reduced Variable Candidates

M_u[DFW:novar]	3-variable, no variance, uniform weighted, on 24-hour DFW EDR
M_{wsv}[DFW_d:nowsv]	5-variable, no wsv, wind_spd_var weighted, on day only DFW EDR
M_{wsv}[DFW_d:dbest5]	Best 5-variable, wind_spd_var weighted, on day only DFW EDR
M_{wsv}[DFW_d:dbest4]	Best 4-variable, wind_spd_var weighted, on day only DFW EDR
lnM_{wsv}[DFW_n:nowsv]	5-var., no wsv, wind_spd_var weighted, on night only DFW ln(EDR)
lnM_{wsv}[DFW_n:nbest5]	Best 5-variable, wind_spd_var weighted, on night only DFW ln(EDR)
lnM_{wsv}[DFW_n:nbest4]	Best 4-variable, wind_spd_var weighted, on night only DFW ln(EDR)

Intra-DFW Validation Models

M_{wsv}[DFW_d^1:all]	6-var., wind_spd_var weighted, on day only part. 1 comp. DFW EDR
M_{wsv}[DFW_d^2:all]	6-var., wind_spd_var weighted, on day only part. 2 comp. DFW EDR
M_{wsv}[DFW_d^3:all]	6-var., wind_spd_var weighted, on day only part. 3 comp. DFW EDR
lnM_{wsv}[DFW_n^1:all]	6-var., wind_spd_var weighted, on night only part. 1 comp. DFW ln(EDR)
lnM_{wsv}[DFW_n^2:all]	6-var., wind_spd_var weighted, on night only part. 2 comp. DFW ln(EDR)
lnM_{wsv}[DFW_n^3 :all]	6-var., wind_spd_var weighted, on night only part. 3 comp. DFW ln(EDR)

Selected Model Definitions

C_0	Intercept
RV_1	Wind speed regression variable
RV_2	Wind speed variance regression variable
RV_3	Wind direction variance regression variable
RV_4	Temperature regression variable
RV_5	Temperature variance regression variable
RV_6	Cloud cover regression variable
C_i, P_i	Coefficient and Power of RV_i, i=1,6

Metrics

ANOVA Statistics

p-value	A probability measure of non-meaningful regression
R^2	Unadjusted percent of variable explained part of total regression variation
Std Error	Estimated standard error (of model coefficient, in percent)
t-statistic	A confidence measure (for non-zero coefficient, in standard deviations)

Evaluation

PE	Model EDR prediction error (PE = $EDR^{\sim}$ - data EDR)
NPE	Data normalized PE (NPE = $PE^{\sim}$/ |data EDR|)
NPE_Mean	Average value of NPE over all data points of the test data set.
NPE_StdDev	Standard deviation of NPE over all data points of the test data set.
NPE_Min	Minimum signed value of NPE over all data points of the test data set.
NPE_Max	Maximum signed value of NPE over all data points of the test data set.
PE_Mean	Average value of PE over all data points of the test data set.
PE_StdDev	Standard deviation of PE over all data points of the test data set.
PE_Min	Minimum signed value of PE over all data points of the test data set.
PE_Max	Maximum signed value of PE over all data points of the test data set.

Data Collection and Preparation

This section provides detailed descriptions of the data sources and procedures used to prepare the model development, model evaluation, and target application data sets. These sources and procedures satisfy the following specified requirements:

- All prepared data sets shall be provided as single ASCII files of comma separated variable (CSV) format.
- The resolution and averaging periods of the data should be every 30 minutes, over the range of the available data.
- EDR data from the highest available tower measurements will be used.
- All data shall be taken from the same site for each airport, the South Site being used for the DFW model development data.
- For the DFW model development data, meteorological data mean and variance shall be obtained from ASOS data.
- For the MEM model evaluation data, 5-meter tower data shall be used (in lieu of insufficient ASOS data) to provide meteorological data mean and variance.

We note the disparity in DFW and MEM data sources for meteorological data mean and variance.

Model Development Data

Sources

A variety of data sources were used for the various data items included in the file provided for model development. The source of each data item is summarized by data type:

Eddy Dissipation Rate (EDR). For 1997, deployment data was available for the period September 15 through October 3. Deployment files of the form YYMMDD_s40_30.edr (YY = year, MM = month, DD = day) provide a forward 30-minute average of EDR values (m^2/s^3) for each 30-minute interval during the deployment dates. The average EDR is contained in the 16th position of each data record.

For 1999, deployment data was available for the period November 15 through November 19 and for November 30 through December 3. For 2000, deployment data was available for June 21 through June 23, for July 11 through July 13, and for July 16 through July 20. For both 1999 and 2000, deployment files of the form tower43s40_edrYYMMDD provide 30-minute forward averages of the u, v, and w EDR components (m^2/s^3) for each 30-minute interval during the deployment dates. The components are contained in the 16th through 18th positions of each data record.

Wind speed and wind direction. For 1997, Automated Surface Observation System (ASOS) files of the form 64010KDFWYYYYMM.dat provide wind speed (kt) and wind direction (degrees from true north) at 5-minute intervals throughout the deployment period. Both quantities are extracted from the data item ending in “KT” in each data record and both are reported as integers. The first three characters in the item represent the wind direction and the next two characters denote the wind speed. The data item sometimes contains gusts, but these values are ignored.

For 1999 and 2000, ASOS Page-1 files of the form 64050KDFWYYYYMM.txt provide wind speed (kt) and wind direction (degrees from true-north) at 1-minute intervals throughout the deployment period. The

wind direction is extracted as an integer from the three columns beginning with column 68 and the wind speed is extracted from the four columns beginning with column 74.

Temperature and dew point. For 1997, the 64010KDFWYYYYMM.dat files also contain temperature and dew point data at 5-minute intervals for each day of the deployment period. Within each data record, the temperature and dew point were located by beginning with the 8th item and scanning for an item containing two integers separated by a "/". The first integer is the temperature and the second is the dew point, (both C°).

For 1999 and 2000, ASOS Page-2 files of the form 64060KDFWYYYYMM.txt contain temperature and dew point values at 1-minute intervals. Within each data record, the temperature is found in the three columns beginning with column 95 and the dew point is found in the three columns beginning with column 100 (both F°).

Day/Night indicator. No day/night data was found to exist for 1997, so corresponding data for 1999 was used as an approximation. ASOS Page-1 data files of the form 64050KDFWYYYYMM.txt contain day/night data for 1-minute intervals. The data is a character "D" or "N" in column 39 of each data record.

Cloud cover, visibility, and general weather. Hourly Abbreviated Surface files of the form HAS0000604791.op contain cloud cover, visibility, and general weather data at roughly 1-hour intervals for all deployment years. When extracting the data, the first entry within an hour corresponding to a minute value of less than or equal to 29 is used for that hour. A reading within an hour with a minute value greater than 29 is associated with the next hour. The cloud cover data is extracted as a 3-character mnemonic beginning in column 42 of each data record. Visibility (statute miles) is extracted as four characters beginning in column 52. General weather is extracted as up to four 2-digit integer codes beginning in columns 57, 60, 63, and 66.

Preparation

The raw data extracted as described above was processed differently depending upon data type. The processing steps are described below.

Eddy Dissipation Rate. For 1997, the average EDR requires no additional processing and is output directly as extracted from the raw data.

For 1999 and 2000, the average EDR is computed as the arithmetic mean of the three components. If one component is missing (i.e., 9999), the average is the sum of the remaining two components. If two components are missing, the average is the third component. If all three components are missing the average is reported as 9999.

Wind speed. For 1997, up to six 5-minute wind speed values were forward averaged into 30-minute intervals and the variances were also calculated. Missing values were excluded from the calculations. If all six values were missing the average and variance are reported as 9999. If exactly five values were missing, the average is reported as the 6th value and the variance is reported as zero. The resultant speeds are reported to the nearest 10th of a Knot and the variances to the nearest 100th.

For 1999 and 2000, the calculations are the same as for 1997 except the averages (and variances) are computed for up to thirty 1-minute values.

Wind direction. For 1997, up to six 5-minute wind direction values were forward averaged into 30-minute intervals and the variances were also calculated. For determining averages, the wind directions were each broken into east-west components and north-south components. The east-west and north-south averages were determined independently. The average angle was then computed as the inverse tangent of the ratio of the east-west average to the north-south average. Angles west of true-north are computed as negative angles and are made positive by adding 360 degrees. The variance is computed by summing the squares of the differences between the raw data values and the computed mean angle. When the difference between the raw data and the mean is more than 180 degrees, the differences are corrected by subtracting 360 degrees. Missing values are not included in the calculations and if exactly five values are missing, the average is the 6th and the variance is zero. If all six values are missing, the average and variance are reported as 9999. The resultant directions are reported to the nearest 10th of a degree and the variances to the nearest 100th.

For 1999 and 2000, the calculations are the same as for 1997 except the averages (and variances) are computed for up to thirty 1-minute values.

Temperature and dew point. For 1997, up to six 5-minute temperature or dew point values were converted to Fahrenheit and were forward averaged into 30-minute intervals and the variances were also calculated. Missing values were excluded from the calculations. If all six values were missing the average and variance are reported as 9999. If exactly five values were missing, the average is reported as the 6th value and the variance is reported as zero. The resultant temperatures are reported to the nearest 10th of a degree and the variances to the nearest 1000th.

For 1999 and 2000, the calculations are the same as for 1997 except the values were already in Fahrenheit and the averages (and variances) are computed for up to thirty 1-minute values.

Day/Night indicator. For each of the thirty 1-minute intervals the average is determined by assigning a 1 to each “D” value and a 0 to each “N”. If the resulting average is greater than 0.5, the indicator is set to 1. Otherwise, it is set to zero. Missing values are not included in the calculations. If exactly 29 values are missing, the remaining value is the average (1 for “D”, 0 for “N”). If all thirty values are missing the indicator is set to 9999.

Cloud cover. A numerical value is assigned to each mnemonic according to table 1:

Table 1. Cloud Cover Mnemonics and Numeric Values

Mnemonic	Value
CLR	0.0
SCT	0.3125
BKN	0.75
OVC	1.0

Visibility. The visibility value is reported exactly as extracted from the raw data. Some missing values are represented in the raw data as “****”. These values are converted to “9999.”

General weather. All of the up-to-four integer codes are concatenated together into a single (up to 8-character) output code. If an integer code is extracted as “**”, it is not included.

Data for all of the three deployment years is output to a single comma separated value (CSV) file. The file contains header information identifying which data is in which position.

Model Evaluation Data

Sources

In order to provide variances for model evaluation it was necessary to use deployment tower data for some of the data types. The source of each data item is summarized by data type:

EDR. Data files of the form YYMMDD_m40_30.edr contain the average EDR value (m^2/s^3) at each 30-minute interval for the year, month, and day specified in the file name. The mean EDR is extracted from the 16th position in each data record. Missing data is output as 9999.

Wind speed, wind direction, temperature, and dew point. Using 5-meter tower data, files of the form SVYYMMDD for 1994 and SVYYMMDD.QA1 for 1995 contain 1-minute observations of each of these data items. Wind speed (m/s) is extracted as the 15th data item for 1994 and as a 6-character value beginning in column 73 for 1995. Wind direction (degrees from true-north) is extracted as the 16th data item for 1994 and as a 6-character value beginning in column 80 for 1995. Temperature (C°) is extracted at the 9th data item for 1994 and as a 7-character value beginning in column 25 for 1995. The dew point (C°) is extracted as the 13th item for 1994 and as a 7-character value beginning in column 57 for 1995.

Day/Night indicator. Day/night data does not exist for 1994 and only for August 1995. A file SUNRISE95.CSV contains daily values for the times of sunrise and sunset for the month of August. All times are given in GMT minus 5 hours.

Cloud cover, visibility, and general weather. Hourly Abbreviated Surface files of the form HAS000057831.op contain cloud cover, visibility, and general weather data at roughly one-hour increments. When extracting the data, the first entry within an hour corresponding to a minute value of less than 29 is used for that hour. A reading within a given hour having a minute value greater than 29 is associated with the next hour. The cloud cover is extracted as a 3-character mnemonic beginning in column 42 of each data record. Visibility (statute miles) is extracted as four characters beginning in column 52. General weather is extracted as up to four 2-digit integer codes beginning in columns 57, 60, 63, and 66.

Preparation

The raw data, extracted as described above, was processed differently depending upon data type. The processing steps are described below.

Eddy Dissipation Rate. The average EDR requires no additional processing and is output directly as extracted from the raw data.

Wind speed. Up to 30 1-minute wind speed items are forward averaged and converted from m/sec to knots. The variance is also computed for each mean wind speed. If all but exactly one wind speed is missing, the remaining speed is the mean and the variance is zero. If all speeds are missing, the mean and variance are reported as 9999.

Wind direction. Up to 30 1-minute wind directions are forward averaged to determine the mean wind direction. The values are broken into east-west and north-south components to compute the means. The computation procedure is the same as described above for processing Dallas/Fort Worth wind directions.

Temperature and dew point. Up to 30 1-minute temperature and dew point readings are forward averaged to compute the means and converted from Centigrade to Fahrenheit. The variance is also computed for each mean. If all but exactly one data item are missing for an average, the remaining item is the mean and the variance is zero. If all items are missing, the mean and variance are reported as 9999.

Day/Night indicator. The data values for sunrise and sunset are each incremented by five hours to reflect GMT values. For each 30 minute average time period, if sunrise occurs during the first 15 minutes of the 30- minute period, the entire period is considered to be day. If it occurs during the last 15 minutes of the period, the entire period is considered night. Similarly, if sunset occurs during the first 15 minutes, the entire period is considered to be night, but if it occurs during the second 15 minutes, the entire period is considered to be day. Day values are reported as integer one and night values are reported as integer zero.

Cloud cover, visibility, and general weather. The processing of cloud cover, visibility, and general weather is exactly the same as reported above for Dallas/Fort Worth.

Data for both deployment years is output to a single comma separated value (CSV) file. The file contains header information identifying which data is in which position.

Target Application Data

Sources

Data extraction was accomplished for eleven additional airports for the entire year 1999. Dallas/Fort Worth data was also expanded to cover the entire year. There is no EDR data available for these airports or for the extended DFW time frame, but all other data items described above were extracted. Table 2 identifies all airports for which target application data sets were prepared. The Memphis International airport (MEM) was not included in this data extraction effort, because comparable data does not exist for 1999.

Table 2. Airports Represented in Target Application Data Sets

Airport Code	Airport Name
ATL	Hartsfield Atlanta International Airport
BOS	Boston Logan International Airport
CLT	Charlotte/Douglas International Airport
DFW	Dallas Fort Worth International Airport
EWR	Newark Liberty International Airport
JFK	John F. Kennedy International Airport
LAX	Los Angeles International Airport
LGA	New York LaGuardia International Airport
MIA	Miami International Airport
ORD	Chicago O’Hare International Airport
SFO	San Francisco International Airport
STL	St Louis International Airport

For each airport, ASOS Page-1 data was available in files of the form 64050KZZZYYYYMM.txt where ZZZ is the 3-character airport designator from the list above. Similarly, ASOS Page-2 data was available for each airport in files 64060KZZZYYYYMM.txt. Additionally, Hourly Abbreviated Surface files identical to the data in HAS0000604791.op were available for the additional airports in files HAS0000604811.op and HAS0000604812.op.

ASOS Page-1 data was used for the extraction of wind speed, wind direction, and day/night indicator values. ASOS Page-2 data was used for the extraction of temperature and dew point values. Hourly Abbreviated Surface data files were used for the extraction of cloud cover, visibility, and general weather. Data extraction methods were identical to those discussed above for 1999 DFW data.

Preparation

Data preparation for all twelve airports is identical to that described above for 1999 DFW. Data for each of the twelve airports is output to a separate comma separated value (CSV) file. Each file contains header information identifying the airport and which data is in which position.

Data Sets Comparison

The DFW and MEM based model development and evaluation data sets exhibit different data characteristics. Contributing factors stemming from AVOSS site deployment schedules include differences in data point quantity and represented seasonal (monthly) periods. An alternative source of meteorological data represents another contributing factor; the use of MEM AVOSS 5-meter tower data, in lieu of insufficient available ASOS data, was necessary to obtain variance values. These differences have already been discussed in the section on data collection and preparation, and are summarized for pre-filtered data sets in table 3. Filtering of both DFW and MEM data sets is performed prior to model development and evaluation to exclude data points that are insufficiently defined, physically non-meaningful, or judged to be outliers. This filtering process, discussed further in the next subsection, may perturb but will not eliminate differences in DFW and MEM data set characteristics.

Table 3. Summary Comparison of Pre-filtered DFW and MEM Data Set Sizes and Sources

Data Set	Year	Months	Number of Data Points	EDR Data Source	Meteorological Data Source
MEM	1994	Dec	144	AVOSS 40m	AVOSS 5m
	1995	Aug	1248	AVOSS 40m	AVOSS 5m
	Total		1392		
DFW	1997	Sep/Oct	912	AVOSS 40m	ASOS 5-minute
	1999	Nov/Dec	432	AVOSS 40m	ASOS 1-minute
	2000	Jun/Jul	528	AVOSS 40m	ASOS 1-minute
	Total		1872		

Site-specific geography and climate represent additional sources of difference in DFW and MEM data set characteristics. Inter-site differences such as these are considered more critical to the ability of a model based on single (in this case DFW) site data to predict EDR at other sites, since their reduction cannot generally be expected by an increase in the quantity or quality of points in the data sets. Their impact may be further evaluated by a future pursuit of the identified target application. Following the subsection on data filtering, characteristic differences in filtered DFW and MEM data will be examined by a comparison of normalized variable value distributions.

Data Filtering

Prior to model development, the DFW data set was filtered to remove data points that are insufficiently defined, physically non-meaningful, or judged to be outliers. Any data point having an undefined value (represented as 9999) for EDR, any of the candidate regression variables, or the day/night indicator is considered insufficiently defined. The candidate regression variables include wind speed, wind direction, temperature, and dew point, their variances, and cloud cover. Any point for which dew point exceeds temperature is considered physically non-meaningful.

No formal statistical metrics are used to identify outliers. Rather, outliers are identified by visual inspection of scatter-plots; EDR versus wind speed for each of those variables, and EDR versus addressed regression variable for the remaining candidate variables. Scatter-plot inspection led to the selection of upper bounds on EDR and certain candidate regression variables for points judged to not be outliers. Table 4 identifies the variables affected and bounds adopted.

Table 4. Variable Bounds for Outlier Filtering

Variable	Upper Bound
EDR	0.0136
Wind speed variance	8.0
Temperature	150.0
Temperature variance	4.0
Dew point variance	10.0

The candidate regression variables wind direction, dew point, and dew point variance were addressed during the preliminary single variable regression tests of model development, but not selected for inclusion in the final models. During these preliminary tests, application of the dew point variance bound filtered out a moderately small number (29) of DFW data points. These points are not filtered out during subsequent model development when dew point variance is not a regression variable. The exclusion of any data points exhibiting a dew point greater than temperature, however, is retained. Consistent exclusion of the small number of data points with zero wind speed variance supports regression weighting by that variable and ensures all candidate EDR model definitions are based on the same set of data points.

Table 5 provides, for the entire DFW data set and its day and night subsets, a breakdown by specific filter of the number of data points excluded during final model development, and the net total number retained. Day/night breakdowns for the insufficient variable definition and zero wind speed variance filters are not available since they are applied before the day/night exclusion filter. Appendix A defines each of the 286 DFW data points (15.3% of the total) excluded for other than day/night selectivity.

Table 5. DFW Data Point Filter Breakdown by Filter Type and Day/Night Subset

Filter Type Applied	All DFW Data	Day DFW Data	Night DFW Data
Insufficient variable definition	241		
Zero wind speed variance	18		
Day/night exclusion	0	738	875
Dew point > temperature	3	3	0
EDR > 0.0136	5	2	3
Wind speed variance > 8.0	12	10	2
Temperature > 150.0	1	0	1
Temperature variance > 4.0	6	4	2
Total for all filters	286 (15.3%)	1016	1142
Total data points retained	1586 (84.7%)	856	730

The model evaluation, or MEM, data set is similarly filtered prior to application of DFW based EDR prediction models. The higher incidence of undefined variable fields in the MEM data point definitions resulted in a much larger percentage (46.3%) of data points excluded for reasons other than day/night selectivity. Table 6 provides, for the entire MEM data set, a breakdown of filtered data points similar to that provided for DFW in table 5. Note that the exclusions are almost entirely due to insufficient variable definition. The few data points that may be excluded on the basis of a zero wind speed variance are reported with them. Appendices B and C provide detailed descriptions of each retained data point in the day and night data subsets. As further discussed later in the model selection section, model predicted EDR and model over-prediction error (model minus data) metrics are included with each data point description.

Table 6. MEM Data Point Filter Breakdown by Filter Type and Day/Night Subset

Filter Type Applied	All MEM Data	Day MEM Data	Night MEM Data
Insufficient variable definition or zero wind speed variance	642		
Day/night exclusion	0	394	467
Dew point > temperature	0	0	0
EDR > 0.0136	1	1	0
Wind speed variance > 8.0	0	0	0
Temperature > 150.0	1	1	0
Temperature variance > 4.0	0	0	0
Total for all filters	644 (46.3%)	1038	1109
Total data points retained	748 (53.7%)	354	283

Variable Value Distributions

One major site dependent difference in the character of DFW and MEM data sets is EDR value distribution. Normalized distributions of EDR for filtered day and night subsets of DFW and MEM data are presented in figures 1 and 2. Each figure compares corresponding DFW and MEM distributions. They show DFW EDR values to be more disperse and generally larger than those for MEM EDR, particularly for night data. Table 7 provides a statistical comparison.

Table 7. EDR Distributions for Filtered DFW and MEM Day/Night Data Sets

Data Set	Mean	Std. Dev.	Minimum	Maximum
DFW Day	2.0300e-03	1.7961e-03	0.0000e+00	1.1640e-02
MEM Day	1.0323e-03	9.8352e-04	1.0100e-06	1.3516e-02
DFW Night	1.7733e-03	1.9565e-03	0.0000e+00	1.2920e-02
MEM Night	4.0067e-04	4.7245e-04	2.1000e-07	2.6119e-03

Separate comparison of day and night data subsets is made in light of the known existence of a nighttime low altitude jet in the DFW vicinity, a phenomenon not occurring in the MEM vicinity. Figure pair 3-4 [8] presents, for DFW and MEM data sets, the mean and 95% distribution bound values for individual data point EDR as a function of local time in hours. A comparison identifies a fundamental difference in MEM and DFW nighttime EDR behavior as well as the generally larger and more disperse EDR values of the DFW data set. While MEM nighttime EDR values remain relatively constant, their DFW counterparts first rise and then fall significantly during the early and late nighttime hours, peaking at about midnight; behavior consistent with the presence of a low altitude nighttime jet. This characteristic difference led to a rejection of local time of day as a candidate model regression variable.

While both DFW and MEM data set EDR generally demonstrate a moderate rise and fall during the local daytime hours, MEM EDR values also demonstrate points of significantly larger mean and variation during the mid to late afternoon. Given the knowledge [Appendices B and C] that filtered MEM data represents only year 1995 data (as a consequence of the lack of a defined day/night indicator for 1994 data), all data points represent the month of August, and afternoon thundershower activity is a plausible explanation for this data characteristic.

Normalized distributions of wind speed, temperature, and wind speed variance, for filtered day and night DFW and MEM data subsets are respectively presented in figure pairs 5-6, 7-8, and 9-10. Again, each figure compares corresponding DFW and MEM distributions. As detailed in later sections, these meteorological variables represent three of the six eventually selected for inclusion in the recommended day and night EDR models. Wind speed and temperature distribution comparisons are presented to show their significant differences. The comparison of wind speed variation distributions is presented since it is the weighting eventually selected for the recommended models. Distribution comparisons for the remaining three selected model variables showed little difference and are not presented.

Figure pair 5-6 shows, for both day and night data, similar significant differences in the normalized distributions of DFW and MEM data set wind speed, the variable destined to be the dominant predictor of EDR variation. In both cases DFW mean and spread is approximately three times that of MEM, with the DFW mean similar in magnitude to the maximum MEM value. Consequently, DFW based models focus EDR prediction with respect to wind speed on values near the MEM maximum, suggesting the potential for increased prediction degradation with decreased MEM wind speed.

Figure pair 7-8 also shows, for day and night data, similar significant differences in the normalized distributions of DFW and MEM data set temperatures. In this case, however, the potential for prediction degradation is expected to be less, since the distributions are more nearly centered and the DFW distributions extend beyond those of MEM.

Figure pair 9-10 indicates that the DFW and MEM data set distributions of wind speed variance are similar for both day and night data, suggesting no significant potential for degradation in EDR prediction from MEM data by a DFW based model utilizing any wind speed variance dependence.

Model Development

Development of the desired EDR prediction model, or more precisely model pair as we shall later see, is described in terms of a method of model definition and its application to a selected training data set. The method consists of selecting a mathematical form and the statistical techniques for fitting that form to a specific training data set. Application of this method results in the definition of a specific model. Repeated application of this development process with varied model form and training data set combinations generated several candidate models for the evaluation and selection steps discussed in later sections. In practice, this entire process of model definition, evaluation, and selection is iterative in nature, with alternative model form selection guided by the performance of previously defined models.

Method

The general mathematical form of all candidate models is governed by the requirement that they must represent a linear multivariable regression on an appropriate subset of the designated list of data variables identified in the requirements portion of the introduction section. While alternative regression fit measures are possible, the well-known minimum least squares error measure was selected. This choice produces maximum likelihood estimates of the regression parameters under the presumption of normally distributed data errors. Candidate model forms are further restricted to contain at most one model term for

each selected regression variable. This restriction was motivated by preliminary tests, which indicated a negligible gain in explained variation when using multiple terms of varied power for single variable regression on wind speed, the dominant EDR prediction variable.

All considered models include an intercept (constant) term in addition to the regression variable terms. Each of the latter terms includes a fixed power on the regression variable as well as a fixed coefficient. These powers are fixed prior to performing multivariable regression of the model form on the selected training data set, which completes model definition by fixing the intercept and regression variable term coefficients. The inclusion of this power does not violate the linearity requirement on the regression model, which applies only to model form fit factors (intercept and term coefficients).

Model Form Selection

Single variable regressions on one-dimensional function forms consisting of an intercept and a single variable term of some fixed power represent the initial, or model form selection, phase of defining a candidate EDR prediction model. These regressions perform two functions; 1) they determine the subset of candidate regression variables to be represented in the model, and 2) they determine near optimal values of the fixed powers for each of the terms representing the predictive contribution of one of these represented regression variables. These determinations are based on the values of two Analysis of Variance (ANOVA) statistics resulting from multiple single variable regressions over a range of trial power values. The PV-WAVE® statistics routine MULTIREGRESS is used to perform these regressions. The intercept and term coefficient pairs produced by these regressions are ignored.

The first ANOVA statistic, the p-value, represents a probability related to the likelihood that the regression performed explains data variation no better than the null hypothesis (i.e. no dependence on the value of the regression variable). We adopt the convention that a p-value of less than 0.05 is sufficient to reject the null hypothesis; that is, the regression performed represents a meaningful dependency and the addressed regression variable should be included in the EDR prediction model form. The second statistic is the unadjusted measure of explained variation, R^2, attributable to the regression variable. This measure identifies explained variation as a percent of total variation. The term power yielding the largest R^2 value is considered optimal for the EDR prediction model form. For all addressed data sets, determining these optimal power values to two significant digits was sufficient to produce maximal R^2 values to at least that level of precision. We use the p-value associated with the regression yielding the largest R^2 value to guide the decision whether or not to include the associated regression variable term in the model form.

As discussed in the next subsection, non-uniform data point weighting is a defining factor in the generation of some candidate EDR prediction models. In anticipation of this, similar weighting is used with the single variable regressions selecting model terms and identifying their optimal powers. During preliminary single variable regression tests, all meteorological variables included in the set of candidate regression variables with their variances were subject to regressions weighted by that variance as well as un-weighted regressions. All final single variable regressions determining optimal term powers for a specific EDR prediction model employed the same weighting variable as that used during the multivariable regression generating that model.

In effect, such weighting would give data points with large-variance meteorological variables greater influence on the fit of the regression on that variable. The resulting ANOVA statistics, particularly R^2 whose maximal value determines the term power selected, are also affected, based on the presumption that the weights applied do approximate the true variance in data error. As later discussed, such variance weighting for selected variables did lead to improved candidate EDR prediction models. Not attempted is an alternative weighting with inverse variance, which would allow less influence on regression of data

points with a high-variance meteorological variable, in support of the conventional association of large variance with large data error.

A second defining factor in the generation of some candidate EDR prediction models is regression on a transformed representation of EDR. The natural log, ln(EDR), of EDR is the chosen transformation since, by virtue of the resulting expanded/contracted scale of small/large EDR values, small value fit is emphasized. This emphasis led to improved prediction of typically lower night EDR values at the risk of over predicting typically larger day EDR. The desirability of ln(EDR) preprocessing with only night data regression is a second motivation for adoption of separate day and night prediction models. Of course, the inverse exponential transformation, exp(.), of such a night model's prediction of ln(EDR) is required.

A preliminary examination of predicted sqrt(EDR) error as a function of its magnitude resulted in a more random distribution than that achieved when addressing EDR directly, indicating a potential for reduced EDR prediction error when using the sqrt(EDR) transformation which, like ln(EDR), favors smaller EDR data points [8]. Figure pair 11-12 compares the error distribution of the ln(EDR) based regression with its EDR based counterpart, where both prediction magnitude and error are multiplied by 1000.

Table 8 presents the addressed set of candidate regression variables. Time of day was excluded based on the previously described difference in character of DFW and MEM data EDR correlation with local time. Other variables of the designated list of candidates not considered include those identifying date, visibility, and weather conditions. The discrete day/night indicator is technically excluded, but its influence is captured when considering distinct day and night model pairs. This two-model approach has the advantage of capturing this influence without introducing discontinuous model forms. In effect, any EDR prediction discontinuity occurs between models, at the boundary of day/night data domains. It is included as the final table entry. Sky conditions are represented in the discrete variable for cloud cover, which is treated as a continuous variable in the models. Variable short names are used in the headers of all prepared files defining site-specific meteorological data. These short names or corresponding symbols are used in the tables and figures of this report.

Table 8. Addressed Set of Candidate Regression Variables

Name	Short Name	Symbol	Units	Type
Wind speed	wind_spd	ws	Knots	Continuous
Wind speed variance	wind_spd_var	wsv	Knots^2	Continuous
Wind direction	wind_dir	wd	Degrees from true north	Continuous/Periodic
Wind direction variance	wind_dir_var	wdv	Degrees^2 from true north	Continuous/Periodic
Temperature	temp	tp	Degrees Fahrenheit	Continuous
Temperature variance	temp_var	tpv	Degrees^2 Fahrenheit	Continuous
Dew point	dewpt	dp	Degrees Fahrenheit	Continuous
Dew point variance	dewpt_var	dpv	Degrees^2 Fahrenheit	Continuous
Cloud cover	cld_cvr	cc	Dimensionless	Discrete/treated as continuous
Day/Night indicator	dn	dn	Dimensionless	Discrete

Model Definition

The second and final development phase of a specific candidate EDR prediction model is the specification by multivariable regression of the intercept and regression variable term coefficients of its associated model form. This regression is performed on the same data set from which were drawn the two-dimensional subsets for all single variable regressions used to determine the inclusion and fixed

powers of the variable terms included in that model form. When used, a single weighting variable applies to all terms. For every candidate EDR prediction model, the single variable regressions defining the fixed powers of the regression variable terms included in its model form and the associated ANOVA statistics, are performed with the same weighting. The PV-WAVE® statistics routine MULTIREGRESS, used to perform all single variable regressions, is also used to perform all multivariable regressions.

Prior to defining a candidate EDR prediction model in this manner, stepwise regression is applied to identify the best alternative models of lower dimension; that is, models having fewer regression variable terms. The PV-WAVE® statistics routine ALLBEST is used for this purpose. This additional (and optional) procedure identifies the optimal order of term inclusion in the sense of increasing the total explained variation of the progressing model, and defines the term coefficients. It is important to realize that simply dropping unwanted terms of the full dimensional model does not generally yield the best model for the retained subset of regression variables. The complete definition of any such alternative model may, like the fully dimensioned model, be obtained by use of the routine MULTIREGRESS, which determines the intercept as well as the term coefficients. The values of term coefficients and ANOVA statistics determined by ALLBEST are the same as those returned by MULTIREGRESS when addressing the same set of regression variables.

Coefficient Precision

Sufficient precision of the intercept and term coefficients defining an EDR prediction model is critical to model accuracy. When the sum of corresponding predictive quantities defining the model EDR prediction contain large and nearly equal values of opposite sign, the precision of that prediction can be much less than that of these intercept and term coefficients. In the one-dimensional case for example, intercept and term values of 10.002 and –10.001, each expressed in five digits of precision yields the sum of 0.001, which contains only one digit of precision and represents reduced accuracy. Large value, relative to typical EDR value, intercept or term coefficients of nearly equal magnitude and opposing sign do occur in most of the candidate EDR prediction models defined on DFW data. This is thought to be the result of strongly correlated dependencies with EDR of multiple regression variables included in the model, and is observed to become more severe with increasing model dimension. Tests using the EDR prediction models recommended by this report demonstrate the need for eight digits of precision in model intercept and term coefficients to ensure at least three digits of accuracy in the predicted EDR values. For this reason, they are defined and should be used with this precision.

Application

Our application of the described model development method begins with a selection of the model regression variable set, based on uniformly weighted, near optimal power, single-variable regressions on the preliminary filtered DFW data set. Selected candidate EDR prediction model forms are then subjected to stepwise and final multivariable regression to identify best alternative models of reduced dimension and define full dimension models. Following a description of regression variable selection, we make some observations on regression variable correlation based on an application of stepwise regression and then describe the selected set of candidate model forms, including the motivation for their selection and a discussion of their characteristics. Definitions of only the selected models are provided in a later section.

Regression Variable Selection

Application of the described model development method to the specified DFW data set begins with a selection of the model regression variable set from the candidates identified in table 8. Uniformly weighted single variable regressions on the entire set of filtered DFW data for each candidate, plus similar variance weighted regressions on those whose variance is available are iteratively performed to identify

near optimal regression powers and corresponding ANOVA R^2 and p-value statistics. Table 9 summarizes the results in order of decreasing R^2 and indicates regression meaningfulness and strength.

Wind speed is the dominant predictor of EDR, and its strength is significantly increased by use of variance weighting, indicating the potential benefit of wind speed variance weighting in a candidate EDR prediction model form. The remaining candidate regression variables that appear to be meaningful and significant when uniformly weighted include wind speed variance, wind direction variance, cloud cover, temperature variance, and temperature. These six are selected as the set of EDR prediction model regression variables.

Variance-weighted wind direction is excluded from consideration as a model regression variable, since the same weighting must be applied to all model terms and the obvious choice, in light of the dominance of wind speed, is wind speed variance. While the same argument may be applied to variance-weighted temperature, its exclusion follows in any case in favor of the slightly stronger uniform weighted temperature. The remaining candidates, including both dew point and its variance, are excluded as non-meaningful. We emphasize that the powers identified in table 9 are not necessarily those used in any candidate EDR prediction models. Separate single regression analyses addressing defining data sets and using variable weighting specific to their corresponding model forms determine the powers used.

Table 9. Near Optimal Power Regression Summaries for the Entire Filtered DFW Data Set

Variable	Weighting	Power	R^2	p-value	Meaningful?
wind_spd	wind_spd_var	3.1	67.72	0.0	Yes-dominant
wind_spd	uniform	3.1	58.93	0.0	Yes-dominant
wind_spd_var	uniform	0.4	7.265	1.57e-14	Yes-moderate
wind_dir_var	uniform	0.35	4.228	0.0	Yes-moderate
cld_cvr	uniform	0.95	2.602	1.54e-10	Yes-weak
temp_var	uniform	1.04	2.542	2.51e-10	Yes-weak
wind_dir	wind_dir_var	0.18	1.138	2.47e-5	Yes-very weak
temp	uniform	1.0	1.077	4.08e-5	Yes-very weak
temp	temp_var	15.0	1.020	6.53e-5	Yes-very weak
dewpt	dewpt_var	0.002	0.7663	5.44e-4	Insignificant
dewpt_var	uniform	0.00001	0.5114	4.75e-3	Insignificant
wind_dir	uniform	0.06	0.2819	3.62e-2	No-large P
dewpt	uniform	4.4	0.0133	6.49e-1	No-large P

Similar uniformly weighted single variable regression analyses on day and night subsets of filtered DFW data that focus on the selected set of six regression variables are summarized in table 10. A comparison of table 9 and 10 optimal powers and predictive strengths (R^2 values) over regression variables, when addressing the different data sets, suggests a potential advantage in using different models for day and night EDR prediction. This use of distinct day and night models is encouraged by the differences in optimal powers when addressing day and night data, particularly with respect to the dominant predicting variable, wind speed. Furthermore, the significantly stronger predictive strengths of the wind and temperature variation variables when addressing night data, and the p-value predicted ineffectiveness of the temperature variation variable when addressing day data, suggests the increased importance of variance data for nighttime prediction. Finally, note that the sum of R^2 values, for uniformly weighted regressions over all six variables of the selected regression set, is larger when addressing day or night only data (79.48 and 87.82 respectively) than when addressing all data (76.64). The significantly stronger night data based sum, is due to the greatly increased R^2 values for wind and temperature variation, since

the predictive power of the dominant wind speed variable is actually decreased compared with its daytime counterpart.

Table 10. Comparison of Uniformly weighted Near Optimal Regressions on Filtered Day/Night DFW Data

Variable	Day DFW Data Only			Night DFW Data Only		
	Power	R^2	p-value	Power	R^2	p-value
wind_spd	3.4	62.74	0.0	3.0	58.77	0.0
wind_spd_var	0.5	7.139	3.44e-14	0.5	7.062	8.07e-13
wind_dir_var	0.41	3.392	5.95e-8	0.34	9.559	0.0
cld_cvr	0.52	3.463	4.30e-8	1.8	2.126	1.04e-4
temp_var	1.4	0.6213	2.12e-2	0.8	6.877	1.60e-12
temp	0.00002	2.126	1.89e-5	10.0	3.423	7.84e-7
Sum of all R^2		79.48			87.82	

Stepwise Regression

Stepwise regression as performed by the PV-WAVE® routine ALLBEST identifies the best subset of the selected regression variables of a given size in terms of maximum total explained variation. While an optional step in the definition of a multivariable regression model involving all selected variables, it provides insight into correlations among these variables and also identifies optimal models of reduced dimension together with their associated reductions in model total explained variation. We first consider stepwise regression using model forms having optimal term powers, based on table 9 and 10 data, for uniform weighted regression on both the entire preliminary filtered DFW data set and its day and night only subsets, and then make some observations on correlation among the selected regression variables.

Table 11 summarizes the addressed stepwise regression on the entire filtered DFW data set. The left side of this table identifies the selected set of regression variables in decreasing order of their predictive power (R^2 value) together with their cumulative sum. Using the variable indices (IDX) defined on the left side, the right side of the table summarizes the optimal order of inclusion of regression variables as the number (NBR) included grows, and identifies the corresponding growth in total explained variation.

Table 11. Optimal Variable Set Content and Total R^2 Growth for Uniform Weighted Regression on All DFW Data

Regression Variables Ordered by Decreasing R^2				Optimal order of Regression Variable Inclusion			
IDX	Variable	R^2	Sum of R^2	NBR	Variables (IDX)	R^2 Growth	Total R^2
1	wind_spd	58.93	58.93	1	1	59.31	59.31
2	wind_spd_var	7.265	66.20	2	1,6	0.45	59.76
3	wind_dir_var	4.228	70.423	3	1,5,6	0.30	60.06
4	cld_cvr	2.602	73.03	4	1,2,5,6	0.20	60.26
5	temp_var	2.542	75.57	5	1,2,3,5,6	0.25	60.51
6	temp	1.077	76.65	6	1,2,3,4,5,6	0.04	60.55

The first observation is that the order of regression variable addition is not the same as might be anticipated, i.e. based on descending predictive power (R^2) as determined during single variable regression. For example, wind speed variance is not the second variable added even though it is second in predictive strength. This suggests a strong correlation between wind speed and its variance, which would minimize the introduction of new orthogonal predictive information. A second observation is that while the total R^2 (predictive strength) of the optimal variable subset increases monotonically from a value slightly greater than that for the dominant predictive single variable, that total is much less than the sum

of R^2 values resulting from single variable regressions on all included model variables. This is additional evidence that there is strong correlation among the selected set of regression variables.

Table 12 illustrates the consistency of this second observation over a range of model form and model defining data set. Both a uniform weighted regression based model form and an alternative based on a preliminary wind speed variance weighted regression are addressed. Each represents all six selected regression variables and employs variable term powers optimized with respect to single variable regressions on both full and day or night only filtered DFW data sets, where the preliminary form of filtering is used. The wind speed variance weighted regression models are quasi-optimal in the sense that an optimal, wind speed variance weighted regression based, term power is used only for the dominant predictive regression variable, wind speed, while the term powers for the remaining regression variables are those found to be optimal when using uniform weighted regression. For this reason the sums of single variable regression R^2 values over all variables are only approximate and arguably too large. Nonetheless, the consistent occurrence, over all six models, of model total R^2 values only slightly higher than those achieved for the dominant predictive variable under single variable regression, and much less than the sums of R^2 values from single variable regressions for all variables, indicates a persistent high level of correlation among the regression variables. The fact that model total R^2 values for both models of pairs based on day and night only data are higher than that for their full (24-hour) data counterpart provide yet another indication of the potential advantage of separately modeling and predicting daytime and nighttime EDR.

Table 12. Six Model Comparison of Model Total R^2 with Dominant Variable and Sum of Variable R^2

Uniform Weighted			Wind Speed Variance Weighted		
24-hour	Daytime	Nighttime	24-hour	Daytime	Nighttime
Model Total R^2					
60.27	63.13	64.07	68.48	70.27	71.64
Independent Single Variable Regression R^2 Sum					
76.64	79.48	87.82	85.43	85.99	95.98
Dominant Single Variable Regression R^2					
58.93	62.74	58.77	67.72	69.25	66.93

Candidate Models

Table 13 identifies the four basic types of model form considered. In addition to the already introduced and first addressed uniform and wind speed variance weighted types applicable to regression on EDR values, we also consider a wind speed weighted alternative to these plus a second wind speed variance weighted type applicable to regression on ln(EDR) values. The former is considered given the known dominance of wind speed as an EDR predictor, while the latter provides additional emphasis on lower EDR value data points, more common during the night, and thereby offers an increased potential for improving nighttime EDR predictions, those less well handled by the first two model types. Table 13 introduces as model type names a short hand convention we adopt to identify model (M) weighting, by a subscript, and EDR representation, by the "ln" prefix for the natural log case.

Table 13. Four Basic Model Types

Name	EDR representation	Data Weighting
M_u	EDR	Uniform
M_{wsv}	EDR	Wind speed variance
M_{ws}	EDR	Wind speed
lnM_{wsv}	Natural Log of EDR	Wind speed variance

Individual candidate model forms are determined by pairing a basic model type with a specific set of training data. Each candidate model form is dependent on the set of training data addressed, and is determined by fixing optimal powers for all six selected regression variables through a maximizing of explained variation during iterated single variable regressions on that data set as detailed in the previous section. Individual candidate models are then defined by fixing model form intercept and variable term coefficients through multivariable regression on either all or some subset of the six selected regression variable values for all data points in the set of addressed training data.

We introduce, as an extension to our model form type naming convention, the following specific model naming convention. A model name has the form "Type[Data:Variables]", where "Type" equals one of the four introduced model form type names, "Data" identifies the specific set of data points "Type" is fit to, and "Variables" identifies the subset of six selected regression variables addressed when determining model form intercept and term coefficients.

"Data" consists of the airport code of the site represented in the data with possible subscript and or superscript. The existence of a subscript, either "d" or "n", indicates only the day/night indicator identified day or night subset of "Data" is addressed, while its absence indicates all of "Data" is addressed. The existence of a superscript indicates only a portion of "Data" or its day or night subset is addressed, while its absence indicates all is addressed. In our case "Data" is always "DFW" since we always train model forms to fit some portion of DFW data. We only use the superscript when referring to models defined during intra-DFW model validation tests, where the complement of one of three representative partitions of DFW, or its day or night subset, is used as training data. Superscripts of "1", "2", or "3" indicate the complement of the first, second, or third partition is used to train the model form, as further discussed in the section on intra-DFW model validation.

Generally, "Variables" identifies by means of conventional set notation, using the values of IDX in table 11, the specific regression variables represented in the model. For example, "Variables" = "{1,4,6}" indicates only wind speed, cloud cover, and temperature, the non-variance variables, are represented. In this report we will use the simpler notation for "Variables" introduced in table 14, addressing only the variable subsets considered during testing.

Table 14. Simple "Variables" Set Notation Used in Model Name Form "Type[Data:Variables]"

Simple Notation	General Set Notation	Significance
all	{1,2,3,4,5,6}	Entire set, as used by selected models.
novar	{1,4,6}	No variance variables, used only during preliminary testing.
nowsv	{1,3,4,5,6}	No wind speed variance, reduced set tested with day and night models.
dbest5	{1,2,3,4,6}	Best 5-variable day model, no temperature variance.
dbest4	{1,2,4,6}	Best 4-variable day model, dbest5 less wind direction variance.
nbest5	{1,2,3,5,6}	Best 5-variable night model, no cloud cover.
nbest4	{1,3,5,6}	Best-4 variable night model, nbest5 less wind speed variance.

Table 15 provides a list, using this naming convention, of all candidate prediction and associated validation models addressed in this report. The models trained on the entire relevant portion of DFW data and evaluated on their predictive ability with regard to MEM EDR data are listed first, the principal six-variable models followed by those reduced variable models considered. The models used during intra-DFW data based validation are listed last. In table 15, the abbreviations "part." and "comp." respectively represent partition and complement.

Table 15. List of Addressed EDR Prediction and Validation Models

Name	Description
Principal Candidates	
M_u[DFW:all]	6-variable, uniform weighted, 24-hour DFW data trained EDR model.
M_{wsv}[DFW:all]	6-variable, wind speed variance weighted, 24-hour DFW data trained EDR model.
M_{ws}[DFW:all]	6-variable, wind speed weighted, 24-hour DFW data trained EDR model.
lnM_{wsv}[DFW:all]	6-variable, wind speed variance weighted, 24-hour DFW data trained ln(EDR) model.
M_u[DFW_d:all]	6-variable, uniform weighted, day only DFW data trained EDR model.
M_{wsv}[DFW_d:all]	6-variable, wind speed variance weighted, day only DFW data trained EDR model.
M_{ws}[DFW_d:all]	6-variable, wind speed weighted, day only DFW data trained EDR model.
lnM_{wsv}[DFW_d:all]	6-variable, wind speed variance weighted, day only DFW data trained ln(EDR) model.
M_u[DFW_n:all]	6-variable, uniform weighted, night only DFW data trained EDR model.
M_{wsv}[DFW_n:all]	6-variable, wind speed variance weighted, night only DFW data trained EDR model.
M_{ws}[DFW_n:all]	6-variable, wind speed weighted, night only DFW data trained EDR model.
lnM_{wsv}[DFW_n:all]	6-variable, wind speed variance weighted, night only DFW data trained ln(EDR) model.
Reduced Variable Candidates	
M_u[DFW:novar]	3-variable, no variance, uniform weighted, 24-hour DFW data trained EDR model.
M_{wsv}[DFW_d:nowsv]	5-variable, no wsv, wind speed variance weighted, day only DFW data trained EDR model.
M_{wsv}[DFW_d:dbest5]	Best 5-variable, wind speed variance weighted, day only DFW data trained EDR model.
M_{wsv}[DFW_d:dbest4]	Best 4-variable, wind speed variance weighted, day only DFW data trained EDR model.
lnM_{wsv}[DFW_n:nowsv]	5-variable, no wsv, wind_spd_var weighted, night only DFW data trained ln(EDR) model.
lnM_{wsv}[DFW_n:nbest5]	Best 5-variable, wind_spd_var weighted, night only DFW data trained ln(EDR) model.
lnM_{wsv}[DFW_n:nbest4]	Best 4-variable, wind_spd_var weighted, night only DFW data trained ln(EDR) model.
Intra-DFW Validation Models	
M_{wsv}[DFW_d^1:all]	6-var., wind_spd_var wghtd., day only part. 1 comp. DFW data trained EDR model.
M_{wsv}[DFW_d^2:all]	6-var., wind_spd_var wghtd., day only part. 2 comp. DFW data trained EDR model.
M_{wsv}[DFW_d^3:all]	6-var., wind_spd_var wghtd., day only part. 3 comp. DFW data trained EDR model.
lnM_{wsv}[DFW_n^1:all]	6-var., wind_spd_var wghtd., night only part. 1 comp. DFW data trained ln(EDR) model.
lnM_{wsv}[DFW_n^2:all]	6-var., wind_spd_var wghtd., night only part. 2 comp. DFW data trained ln(EDR) model.
lnM_{wsv}[DFW_n^3 :all]	6-var., wind_spd_var wghtd., night only part. 3 comp. DFW data trained ln(EDR) model.

Model Evaluation

In this section we present test results for and provide a comparative evaluation of all candidate EDR prediction models. Following a description of the evaluation metrics used, the EDR prediction performance for each principle candidate model when applied to the appropriate portion of the MEM data set is summarized and compared in terms of these metrics. Distributions of model prediction error are also discussed and compared. We also provide a similar treatment of the reduced variable candidate models, including discussions addressing the reasons for their consideration.

Metrics

The chosen measure of model prediction error, PE, is a signed difference between the model predicted EDR value for a given data point in the addressed model evaluation data set and the corresponding forward 30-minute average of sensor EDR values provided as the representative measure of EDR for that data point. Equation (1) provides the definition of this measure of EDR prediction error.

$$PE = \text{model predicted EDR value} - \text{data point defined EDR value} \quad (1)$$

Using this definition, a positive PE value indicates over-prediction, while a negative value indicates under-prediction. This distinction is significant since under-prediction of EDR is conservative when the application of the predicted value is, as for AVOSS, an estimation of wake vortex decay, while over-prediction is not. Under-predicted EDR is conservative because it leads to under-estimation of wake vortex decay rates, resulting in larger and safer estimates of inter-aircraft spacing.

The chosen measure of model performance is a data normalized version of PE as defined in equation (2).

$$NPE = PE \,/\, |\text{data point defined EDR value}| \qquad (2)$$

This measure allows model performance comparison through error ratio analysis, and is useful for determining the extent to which model performance satisfies the basic requirement that EDR predictions be within the correct order of magnitude. The division by the magnitude of the data point defined EDR value poses no problem when the model evaluation data set is taken from the MEM data, since table 7 shows the minimum MEM data EDR value is 2.1000e-07. When performing validation of selected models through intra-DFW testing, the few zero DFW data point EDR values are replaced with the value 1.0e-08. This not only avoids division by zero when computing normalized model error, it also allows safe transformation to ln(EDR) for use with EDR prediction models derived from the natural log basic model form type, $\ln M_{wsv}$.

Both PE and NPE are point-wise measures. The principal metrics adopted for model evaluation and comparison are, as identified in table 16, the four statistical measures of the entire vector of the normalized prediction errors, NPE, over the model evaluation data set. These statistical measures were computed with the help of the PV-WAVE® statistics routine SIMPLESTAT.

Table 16. Metrics used for Evaluation of Candidate EDR Prediction Models

Name	Description
NPE_Mean	Average value of NPE over all data points of the evaluation data set.
NPE_StdDev	Standard deviation of NPE over all data points of the evaluation data set.
NPE_Min	Minimum signed value of NPE over all data points of the evaluation data set.
NPE_Max	Maximum signed value of NPE over all data points of the evaluation data set.

NPE_Mean and NPE_StdDev measures are the primary measures. NPE_Mean represents a measure of model bias, with magnitudes of less than 1.0 and less than 10.0 respectively indicating average EDR prediction to the correct magnitude and within one order of the correct magnitude. Negative values represent a conservative bias and are generally preferred over positive values even when they are somewhat larger in magnitude. NPE_StdDev represents a measure of goodness-of-fit, and values between 10.0 and 100.0 indicate that most EDR predictions are accurate to within one to two orders of magnitude.

The remaining two statistical measures for model evaluation, NPE_Min and NPE_Max, identify the smallest and largest signed values of NPE over the entire model evaluation data set. Typically NPE_Min and NPE_Max values will respectively be negative and positive. The magnitude of a positive NPE_Max identifies the worst EDR over-prediction made, while the magnitude of a negative NPE_Min identifies the worst EDR under-prediction. A positive NPE_Min value or negative NPE_Max value indicates that EDR over-prediction or under-prediction, respectively, occurred at all data points of the model evaluation data set, the least of which having a measured EDR normalized magnitude equal to the magnitude of the positive NPE_Min or negative NPE_Max statistical measure.

Secondary model evaluation metrics, computed directly by SIMPLESTAT, are the mean, standard deviation, maximum, and minimum statistical measures on vectors of data and model predicted EDR values and the actual EDR prediction error, PE. When applied to EDR values, they are referred to as Mean, StdDev, Max, and Min. When applied to PE, they are referred to as PE_Mean, PE_StdDev, PE_Min, and PE_Max. PE_Min and PE_Max interpretation is similar to that described for NPE_Min and NPE_Max. Min and Max are simply the signed minimum and maximum of the vector of EDR values.

Performance

Principal Candidate Models

Summaries of all principal candidate model EDR predictions are presented in similarly constructed tables of the introduced statistical measures. Tables 17 and 18, respectively, address model predicted EDR values and corresponding non-normalized prediction errors as defined by equation (1). Table 19 presents the primary model evaluation data in terms of table 16 metrics for normalized EDR prediction error, NPE.

All tests reflected in these tables apply candidate EDR prediction models, trained on specific model development data (DFW) subsets, to equivalent subsets of the model evaluation (MEM) data set. For example, models trained to day only DFW data are used to predict EDR for day only MEM data points. While some testing of 24-hour and day only DFW data trained models to predict EDR values for night MEM data was performed, none achieved a performance level equal or greater to the best identified night model, and are not addressed in these tables.

Information in all three tables is organized row-wise by model form type within model training data set, with each row addressing a specific candidate model. These tables all present, column-wise, values of the appropriate set of four statistical measures for each model. Table 17 also includes, for ease of comparison, equivalent statistical summaries of the corresponding subsets of the model evaluation (MEM) data set, the day and night only rows repeating statistics introduced in table 7. Table 18 also includes a figure reference column labeled “Fig. Dist/Fit”, under which the first number identifies the figure presenting PE distribution, and the second identifies the figure presenting plot pairs of predicted EDR (EDR˜) versus measured EDR and PE over all evaluated MEM data points.

Table 17. Statistical Summary of EDR Value Predictions by Principal Candidate Model

Model	Mean	StdDev	Min	Max
24-hour MEM Data				
	7.0078e-04	8.1160e-04	2.1000e-07	1.3516e-02
24-hour Models				
M_u[DFW:all]	8.6110e-04	3.6412e-04	-1.2895e-03	1.9674e-03
M_{wsv}[DFW:all]	9.3580e-04	4.0656e-04	-4.1614e-03	1.9523e-03
M_{ws}[DFW:all]	8.0683e-04	7.7079e-04	-1.2718e-02	2.3531e-03
$\ln M_{wsv}$[DFW:all]	4.6765e-04	2.6756e-04	1.7031e-09	1.8220e-03
Day Only MEM Data				
	1.0323e-03	9.8352e-04	1.0100e-06	1.3516e-02
Day Only Models				
M_u[DFW_d:all]	1.0473e-03	5.7835e-04	4.8343e-04	1.0564e-02
M_{wsv}[DFW_d:all]	9.6961e-04	5.7939e-04	6.1120e-05	1.0159e-02
M_{ws}[DFW_d:all]	8.8716e-04	4.2245e-04	-3.3455e-03	2.5132e-03
$\ln M_{wsv}$[DFW_d:all]	9.1513e-04	8.0863e-04	5.2415e-04	1.5000e-02 *
continued				

Model	Mean	StdDev	Min	Max
Night Only MEM Data				
	4.0067e-04	4.7245e-04	2.1000e-07	2.6119e-03
Night Only Models				
$M_u[DFW_n:all]$	6.1851e-04	3.7642e-04	-6.7356e-04	1.3281e-03
$M_{wsv}[DFW_n:all]$	9.3316e-04	3.0474e-04	-2.7707e-04	1.5822e-03
$M_{ws}[DFW_n:all]$	5.0281e-04	6.7620e-04	-1.5711e-03	1.4673e-03
$lnM_{wsv}[DFW_n:all]$	1.9150e-04	1.6154e-04	6.2300e-06	8.5100e-04

* Value of Maximum is the upper bound imposed by the model at a single data point, actual value was ~ 40.

We make the following observations of table 17 entries: 1) The 24-hour ln(EDR) prediction model, $lnM_{wsv}[DFW:all]$, is the only 24-hour model that predicted no negative EDR values; 2) The night version of this model form type, $lnM_{wsv}[DFW_n:all]$, is the only night data specific model predicting a conservative mean EDR value and a minimum EDR value approaching the night data minimum, but the standard deviation of its predictions are significantly lower than that for the other night models and the night data; 3) The day version of the wind speed variance weighted EDR model form type, $M_{wsv}[DFW_d:all]$, is the best day model at approaching minimum day data EDR values and also achieves a conservative predicted EDR bias, the latter a characteristic not achieved by the 24-hour and night versions of this model form type; 4) The day version of ln(EDR) model form type, $lnM_{wsv}[DFW_d:all]$, requires an artificial bound (set at 0.015) on predicted EDR to prevent potential gross over-prediction, as evidenced by the annotation on its Max statistical measure, and also is worst among the day models at approaching the minimum night data EDR value; 5) All models based on the wind speed weighted model form type exhibit negative EDR predictions of much larger magnitude than all other models in their data class.

Table 18. Statistical Summary of Actual Model Error (PE) by Principal Candidate Model

Model	Fig. Dist/Fit	PE_Mean	PE_StdDev	PE_Min	PE_Max
24-hour Models					
$M_u[DFW:all]$	13/25	1.6032e-04	8.5633e-04	-1.4805e-02	1.5173e-03
$M_{wsv}[DFW:all]$	14/26	2.3503e-04	9.4898e-04	-1.7677e-02	1.7892e-03
$M_{ws}[DFW:all]$	15/27	1.0605e-04	1.2772e-03	-2.6234e-02	2.1502e-03
$lnM_{wsv}[DFW:all]$	16/28	-2.3313e-04	7.1199e-04	-1.3515e-02	6.8428e-04
Day Only Models					
$M_u[DFW_d:all]$	17/29	1.5030e-05	5.9310e-04	-3.2571e-03	1.4255e-03
$M_{wsv}[DFW_d:all]$	18/30	-6.2666e-05	5.7673e-04	-3.3564e-03	1.2546e-03
$M_{ws}[DFW_d:all]$	19/31	-1.4511e-04	1.0493e-03	-1.6861e-02	9.8581e-04
$lnM_{wsv}[DFW_d:all]$	20/32	-1.1715e-04	6.3934e-04	-3.6471e-03	4.3055e-03
Night Only Models					
$M_u[DFW_n:all]$	21/33	2.1784e-04	4.7750e-04	-1.5743e-03	1.0895e-03
$M_{wsv}[DFW_n:all]$	22/34	5.3250e-04	5.0907e-04	-1.3922e-03	1.4782e-03
$M_{ws}[DFW_n:all]$	23/35	1.0214e-04	7.0369e-04	-2.2891e-03	1.3633e-03
$lnM_{wsv}[DFW_n:all]$	24/36	-2.0916e-04	3.9637e-04	-2.3147e-03	2.4344e-04

24-hour model qualitative analysis. A comparison of the distributions of PE for the 24-hour candidate models, presented in figures 13-16, indicates that, for all four models, the majority of PE have magnitudes of less than 0.001 and nearly all have magnitudes less than 0.002. The distribution for $lnM_{wsv}[DFW:all]$ appears to be the best, having the highest percentage (36%) of PE near 0.0, nearly all positive PE magnitudes less than 0.0005, and nearly all negative PE magnitudes less than 0.0015. As these figures indicate, this distribution also has the least non-conservative (positive) bias. The peak distribution

percentages for the models M_{wsv}[DFW:all] and M_{ws}[DFW:all] are slightly less (31% and 32%) and shifted to a slightly more positive PE position, which together with their increased positive PE distribution indicates a greater risk of EDR over-prediction. The M_u[DFW:all] model appears to yield the poorest performance with the lowest distribution peak (27%) and similar bias and spread.

A comparison of the corresponding plots of $EDR^{\sim}$ versus EDR and PE, presented in figures 25-28, provides additional insight regarding relative model performance. The common plot of MEM data identifies a single MEM data point with an EDR value nearly three times greater than the next largest. A reference to table 7 identifies this to be a daytime data point with an EDR of approximately 0.0135. All models fail to produce a reasonable $EDR^{\sim}$ for this data point, and $\ln M_{wsv}$[DFW:all] is the only model producing a positive $EDR^{\sim}$ for this point. The only other model to produce no additional negative $EDR^{\sim}$ is M_{wsv}[DFW:all]. The most and largest negative $EDR^{\sim}$ are predicted by M_{ws}[DFW:all]. A comparison of PE plots identifies $\ln M_{wsv}$[DFW:all] as generally producing the smallest positive PE. The other three models exhibit generally larger positive PE for approximately the first 120 data points, and positive PE larger than those of $\ln M_{wsv}$[DFW:all] for the remainder. The reason is illustrated by a comparison of the $EDR^{\sim}$ versus EDR plots for $\ln M_{wsv}$[DFW:all] and M_{wsv}[DFW:all], which shows the former to better follow the variation in EDR by more accurate approximation of the smaller EDR, without the tendency shown by M_u[DFW:all] and especially M_{ws}[DFW:all] to produce negative $EDR^{\sim}$. Based on this qualitative analysis, the best and next best 24-hour models, respectively, appear to be $\ln M_{wsv}$[DFW:all] and M_{wsv}[DFW:all].

Day model qualitative analysis. A comparison of the distributions of PE for the day only candidate models, presented in figures 17-20, indicates that, for all four models, spreads in PE are generally similar in magnitude to those associated with the 24-hour models, but exhibit a moderate non-monotonic character left of their peak. The model showing the least positive bias is now M_{ws}[DFW_d:all], but it also yields the greatest distribution spread. The next best (least positive) bias appears to be obtained for M_{wsv}[DFW_d:all], while M_u[DFW_d:all] appears to have the largest positive bias, demonstrating a positive-side distribution shape with a weaker decrease in the occurrence of positive PE with increasing magnitude, compared with the other day only models. Generally, the PE distribution for $\ln M_{wsv}$[DFW_d:all] appears to be satisfactory, but exhibits evidence that the model occasionally produces substantially over-predicted $EDR^{\sim}$. A comparison of $\ln M_{wsv}$[DFW_d:all] and M_{wsv}[DFW_d:all] PE distributions as a function of the dominant EDR prediction variable, wind speed, presented in figures 37 and 38, demonstrates the former can over-predict EDR for high winds (greater than 10 knots) while the latter, like the other two day only models, can be expected to under-predict.

A comparison of the corresponding plots of $EDR^{\sim}$ versus EDR and PE, presented in figures 29-32, provides additional insight regarding relative model performance. The common plot of MEM data confirms the single data point with exceptionally large EDR to be in the MEM daytime subset. The only model predicting a negative EDR is M_{ws}[DFW_d:all], and does so for the data point with this exceptionally large EDR. For this data point, $\ln M_{wsv}$[DFW_d:all] yields the grossly over-predicted EDR whose occurrence is annotated in table 17. For these reasons alone, these two candidate day models appear to be poor choices. Of the remaining two models, M_{wsv}[DFW_d:all] appears to better track data EDR values, as a comparison of their $EDR^{\sim}$ versus EDR plots illustrate. Based on this qualitative analysis, the best and next best day models, respectively, appear to be M_{wsv}[DFW_d:all] and M_u[DFW_d:all].

Night model qualitative analysis. A comparison of the distributions of PE for the night only candidate models, presented in figures 21-24 reveals a marked increase in non-monotonic character and spread left of their peaks, relative to their right sides. The PE distribution for $\ln M_{wsv}$[DFW_n:all] demonstrates a negative bias and a compact monotonic distribution right of the peak, which lies below zero. The maximum PE value for this model is approximately 0.00025. The PE distributions for the other three

night models each exhibit a strong positive bias and small degree of non-monotonic character on their right sides. Maximum PE values are all greater than 0.001. A comparison of $\ln M_{wsv}[DFW_n{:}all]$ and $M_{wsv}[DFW_n{:}all]$ PE distributions as a function of the dominant EDR prediction variable, wind speed, presented in figures 39 and 40, demonstrates, for the smaller range of nighttime MEM wind speed, increasing EDR under-prediction as a function of increasing wind speed. This comparison also demonstrates $\ln M_{wsv}[DFW_n{:}all]$ under-predicts EDR over the entire range of MEM nighttime wind speed, while $M_{wsv}[DFW_n{:}all]$ over-predicts EDR for all but the largest wind speed values in this range.

A comparison of the corresponding plots of $EDR^{\sim}$ versus EDR and PE, presented in figures 33-36, provides additional insight regarding relative model performance. The only model not predicting a negative EDR is $\ln M_{wsv}[DFW_n{:}all]$. Small negative EDR values are predicted only twice by $M_{wsv}[DFW_n{:}all]$, but the other two night models routinely predict negative EDR values, particularly $M_{ws}[DFW_n{:}all]$ whose negative predictions are significantly larger and more frequent. Furthermore, EDR over-prediction magnitudes by $\ln M_{wsv}[DFW_n{:}all]$ are generally three to four times smaller than those for the other three night models. Based on this qualitative analysis, $\ln M_{wsv}[DFW_n{:}all]$ is by far the best choice of night model candidates, with $M_{wsv}[DFW_n{:}all]$ being a distant and only other reasonable alternative.

Order-of-Magnitude quantitative analysis. The normalized EDR model prediction error metrics provided in table 19 quantitatively corroborate the preceding qualitative analyses. Given that error normalization is point-wise with respect to the forward 30-minute average of raw sensor EDR values provided in the MEM model evaluation data, these metrics allow this quantitative evaluation to be in terms of order-of-magnitude over the entire range of MEM data EDR values.

Table 19. Statistical Summary of Normalized Model Error (NPE) by Principal Candidate Model

Model	NPE_Mean	NPE_StdDev	NPE_Min	NPE_Max
24-hour Models				
$M_u[DFW{:}all]$	2.1481e+01	1.6026e+02	-2.8267e+00	3.0744e+03
$M_{wsv}[DFW{:}all]$	2.2352e+01	1.4132e+02	-2.7590e+00	2.3307e+03
$M_{ws}[DFW{:}all]$	1.8221e+01	1.5339e+02	-1.9559e+02	2.8989e+03
$\ln M_{wsv}[DFW{:}all]$	9.8831e+00	7.8272e+01	-1.0000e+00	1.5707e+03
Day Only Models				
$M_u[DFW_d{:}all]$	7.4058e+00	5.6459e+01	-7.1399e-01	7.4341e+02
$M_{wsv}[DFW_d{:}all]$	4.8385e+00	3.7540e+01	-6.9572e-01	4.3191e+02
$M_{ws}[DFW_d{:}all]$	5.5512e+00	4.4674e+01	-1.6781e+00	6.0569e+02
$\ln M_{wsv}[DFW_d{:}all]$	5.9803e+00	4.5164e+01	-7.4618e-01	5.3896e+02
Night Only Models				
$M_u[DFW_n{:}all]$	3.8589e+01	2.5334e+02	-7.7495e+01	3.2065e+03
$M_{wsv}[DFW_n{:}all]$	7.0644e+01	3.8514e+02	-2.4518e+01	4.6383e+03
$M_{ws}[DFW_n{:}all]$	3.1083e+01	3.0590e+02	-6.3911e+02	3.9582e+03
$\ln M_{wsv}[DFW_n{:}all]$	7.8113e+00	5.4334e+01	-9.2928e-01	7.1566e+02

We first observe that the NPE_Mean value for all models is positive, indicating a positive model bias from the standpoint of data normalized EDR prediction error, even though a negative bias is identified for some models on the basis of non-normalized prediction error defined PE_Mean values, as presented in table 18. For example, the value of NPE_Mean for $\ln M_{wsv}[DFW_n{:}all]$ in table 19 is positive, even though the corresponding value of PE_Mean in table 18 is negative. This apparent contradiction could be explained by the presumption that lower valued EDR are predicted with generally more frequent and/or a greater normalized positive bias than are higher valued EDR. Under this presumption, the normalized mean EDR error or bias, NPE_Mean, will generally be positive, due to the increased influence of the

lower EDR value predictions, even when the non-normalized EDR error or bias, PE_Mean, is negative. In the case of $lnM_{wsv}[DFW_n{:}all]$, evidence for this presumption is found in both plots of $EDR^{\sim}$ versus EDR and PE versus wind speed, respectively presented in figures 36 and 39. A comparison of the overlapping $EDR^{\sim}$ and EDR plots of figure 36 illustrates that low valued EDR are generally over-predicted to a greater extent than high valued EDR. Figure 39 illustrates that lower values of wind speed, the dominant EDR predictor, lead to a reduced EDR under-prediction.

We also observe that all NPE_Min values are negative and all NPE_Max values are positive. This means that the magnitude of NPE_Min for each model identifies the largest ratio of under-prediction represented by predicted EDR magnitude over all model addressed MEM data points, relative to data EDR magnitude.

For each of the three classes of candidate models, 24-hour, day only, and night only, one model is clearly the best performer in predicting MEM data EDR on the basis of point-wise data normalized error metrics. The best model in each class exhibits the lowest magnitude within that class for every one of these four metrics. Table 20 identifies the best model in each class and quantifies, with inequality expressions, that performance with respect to predicted EDR positive bias (NPE_Mean), goodness of fit (NPE_StdDev), and maximum under- and over-prediction (NPE_Min and NPE_Max) in terms of orders of data EDR magnitude. Maximum under-prediction and over-prediction typically occur for, respectively, near largest and near smallest measured EDR.

Table 20. Best Candidate Models and Order-of-magnitude Performance on MEM Data EDR Prediction

Class	Model	Metric Inequality	Data EDR Order-of-magnitude Performance Implied
24 Hour	$lnM_{wsv}[DFW{:}all]$	NPE_Mean < 10	Positive bias within one order of magnitude
		NPE_StdDev < 80	Goodness of fit well within two orders of magnitude
		NPE_Min = 1	Maximum under-prediction of zero order magnitude (100%)
		NPE_Max < 1600	Maximum over-prediction of about three orders of magnitude
Day Only	$M_{wsv}[DFW_d{:}all]$	NPE_Mean < 5	Positive bias well within one order of magnitude
		NPE_StdDev < 40	Goodness of fit well within two orders of magnitude
		NPE_Min < 1	Maximum under-prediction of less than zero order magnitude
		NPE_Max < 500	Maximum over-prediction well within three orders of magnitude
Night Only	$lnM_{wsv}[DFW_n{:}all]$	NPE_Mean < 8	Positive bias well within one order of magnitude
		NPE_StdDev < 55	Goodness of fit well within two orders of magnitude
		NPE_Max < 750	Maximum over-prediction well within three orders of magnitude
		NPE_Min < 1	Maximum under-prediction of less than zero order magnitude

A comparison of metric inequalities of the best 24-hour model with those of the best day only and night only models indicates that improved overall prediction of MEM data EDR is achieved with distinct day and night models in place of a single 24-hour model.

Reduced Variable Models

The considered reduced variable alternatives to the principal candidate models include an initial variance variable independent model and the stepwise regression identified best four- and five-variable models based on the model form types leading to the best day and night only principal candidate models addressed in table 20. Two additional considered five-variable alternatives, based on the same model form types, exclude wind speed. We discuss in the next paragraphs the reasons for their consideration and their performance.

Variance variable independent. The EDR prediction models initially considered were forced to exclude wind speed variance, wind direction variance, and temperature variance due to their unavailability in a preliminary MEM data set. The lack of a day/night indicator in this preliminary data set also limited consideration to 24-hour models. Furthermore, the lack of variance data precluded consideration of variance-weighted models. The resulting one-, two-, and three-variable, uniformly weighted, 24-hour models all fail significantly in their ability to approximate lower magnitude EDR. Their mean predicted EDR values are all greater than 0.0011, more than twice the table 17 presented value, 4.6765e-04, achievable by the best full variable 24-hour model, $\ln M_{wsv}$[DFW:all]. Their minimum magnitude predicted EDR values are all greater than 0.0006, only slightly less than the mean MEM data EDR value, 7.0067e-04 (compare with table 7 presented mean EDR values for day and night only data points, 1.0323e-03 and 4.0067e-04), and much greater than the minimum day and night MEM data EDR values, 1.0100e-06 and 2.1000e-07, presented in table 7. The two- and three-variable models perform similarly to the one-variable model using only the dominant predictor, wind speed.

An analysis of the minimum EDR prediction bound for the three-variable, uniformly weighted, 24-hour model (M_u[DFW:novar]) trained on 24-hour DFW data indicates the lack of sufficient negative term contributions to significantly reduce the value of the intercept as the underlying problem. Equation (3) provides a definition of this model in terms of intercept and term coefficients and powers, where “^” indicates exponentiation.

$$\begin{aligned}\tilde{EDR} = 1.6628\text{e-}03 &+ (6.2893\text{e-}07*\text{wind\_spd}\hat{}3.1) + \\ &(-5.3652\text{e-}05*\text{cld\_cvr}\hat{}0.95) + (-1.0821\text{e-}05*\text{temp}\hat{}1.0)\end{aligned} \tag{3}$$

If we assume a zero wind_spd, the maximum value of cld_cvr (1.0), and the maximum MEM data value for temp (95.0), we see by the following evaluation of (3) that maximum negative term contributions are insufficient to produce $\tilde{EDR}$ values significantly smaller than the mean MEM data value, and yield values larger than the best full variable, 24-hour model, mean predicted EDR [table 17].

$$\tilde{EDR} = 1.6628\text{e-}03 + 0.0 - 5.3652\text{e-}05 - 1.0280\text{e-}03 = 5.8115\text{e-}04$$

A similar analysis of the full variable, uniformly weighted, 24-hour model trained on 24-hour DFW data indicates the smaller EDR predictions possible with the availability of additional negative contributions from the wind direction variance and temperature variance terms. Equation (4) provides a definition of this model in terms of intercept and term coefficients and powers, where “^” indicates exponentiation.

$$\begin{aligned}\tilde{EDR} = 1.7487\text{e-}03 &+ (5.9212\text{e-}07*\text{wind\_spd}\hat{}3.1) + (3.9399\text{e-}04*\text{wind\_spd\_var}\hat{}0.4) + \\ &(-3.5419\text{e-}05*\text{wind\_dir\_var}\hat{}0.35) + (-1.1727\text{e-}04*\text{cld\_cvr}\hat{}0.95) + \\ &(-2.2381\text{e-}04*\text{temp\_var}\hat{}1.04) + (-1.3004\text{e-}05*\text{temp}\hat{}1.0)\end{aligned} \tag{4}$$

Again, we assume a zero wind_spd, the maximum value of cld_cvr (1.0), and the maximum MEM data value for temp (95.0). Evaluating only the terms of equation (4) involving these non-variance variables, we have:

$$\begin{aligned}\tilde{EDR} = {}&1.7487\text{e-}03 + 0.0 - 1.1727\text{e-}04 - 1.2354\text{e-}03 + \\ &(3.9399\text{e-}04*\text{wind\_spd\_var}\hat{}0.4) + (-3.5419\text{e-}05*\text{wind\_dir\_var}\hat{}0.35) + \\ &(-2.2381\text{e-}04*\text{temp\_var}\hat{}1.04)\end{aligned}$$

or

$EDR^{\sim} = 3.9603e\text{-}04 + \text{variance variable terms}$

Which, without variance term contributions, already results in a lower EDR minimum. If we also assume a zero wind_spd_var, the only remaining term making a positive contribution to EDR˜ is eliminated. Considering the nominal values for wind_dir_var and temp_var, say 90.0 and 1.0 respectively, both well within their MEM data distribution ranges, we obtain -1.7109e-04 and -2.2381e-04 as the resulting term contributions. Either will significantly reduce EDR˜ from 3.9603e-04, and their combination would result in an EDR˜ value of 1.13e-06. This demonstrates the potential ability of the addressed full variable model to produce EDR predictions of the same magnitude as the minimum day MEM data EDR value. This analysis does not take into account the likelihood of occurrence for the addressed combination of values for the model variables.

Best reduced variable models. A review of the intercept and coefficient values for the best day and night only full variable models, $M_{wsv}[DFW_d:all]$ and $lnM_{wsv}[DFW_n:all]$, provided later in tables 22 and 25 of the model selection section, reveals predicted EDR˜ values involve small differences between large values of nearly equal magnitude. For example, the intercept for $M_{wsv}[DFW_d:all]$ has the value (to five digits of precision) of 12.362 while the sum of the wind speed variance and temperature term coefficients has the value -12.358. This sum very closely approximates the sum of these two terms since their term powers are respectively 1.0e-05 and 2.0e-05, leading to variable power values very nearly equal to one. The resulting sum of these two terms and the intercept is approximately 0.002, and represents a loss of four digits of precision. For $lnM_{wsv}[DFW_n:all]$, a similar loss of precision results from the difference between the intercept (3828.8, to five places) and wind speed variance term, very nearly equal (by virtue of its 2.0e-05 power) to its coefficient value of -3855.9. Such loss of precision in EDR˜ values, relative to the precision in which the model intercept and term coefficients are expressed, leads to the previously identified requirement for eight digits of precision, as defined in tables 22 and 25 of the model selection section, to retain at least three digits of precision in EDR˜.

Reviews of the variation in model intercept and term coefficient magnitudes as a function of the best models of increased dimension generated during stepwise regression, and associated deterioration (growth) of p-values for certain variables, resulted in a consideration of best models of reduced dimension, that is reduced variable models, as alternatives to full variable candidates. For reduced variable day model alternatives to $M_{wsv}[DFW_d:all]$, the intercept p-value becomes poor (> 0.05) with the introduction of temperature as the third variable, and remains poor as additional variables are added. In the full model, $M_{wsv}[DFW_d:all]$, p-values for the fifth and sixth added variables, wind direction variance and temperature variance, are also poor (> 0.05). For reduced variable night model alternatives to $lnM_{wsv}[DFW_n:all]$, the introduction of wind speed variance as the fifth variable generates the large opposing values for its coefficient and the intercept. The p-values associated with both also become poor (> 0.05) at this point.

Reference 9 states that over-modeling of the training data set, while reducing training error, will generally lead to a larger prediction error when applied to a distinct test data set. The reduced bias (squared difference between the “true” model mean and the expected value of the estimating model) with increased complexity of the estimating model is generally accompanied by an increase in the variance of the estimating model error.

For these reasons the four- and five-variable alternative models identified in table 15 were evaluated. In addition to the best four- and five-variable alternatives to the best performing day and night only principal candidate models, five-variable alternatives intentionally omitting wind speed variance were evaluated in light of the large increases in $lnM_{wsv}[DFW_n:all]$ intercept and wind speed variance coefficient magnitudes

and their p-values when wind speed variance was introduced as a variable. Table 21 provides a summary of their performance in terms of the normalized EDR model prediction error metrics, allowing a direct comparison with the principal candidate model performance summary provided in table 19. This performance summary, like those presented in table 19, reflects the application of day and night specific models to, respectively, day and night specific subsets of the MEM data set.

Table 21. Statistical Summary of Normalized Model Error (NPE) by Best Reduced Variable Models

Model	NPE_Mean	NPE_StdDev	NPE_Min	NPE_Max
Day Only Models				
M_{wsv}[DFW_d:nowsv]	9.2448e+00	6.6167e+01	-7.3041e-01	8.1429e+02
M_{wsv}[DFW_d:dbest5]	4.9021e+00	3.8011e+01	-6.9405e-01	4.3493e+02
M_{wsv}[DFW_d:dbest4]	4.3426e+00	3.4849e+01	-2.3169e+00	3.8200e+02
Night Only Models				
lnM_{wsv}[DFW_n:nowsv]	2.3633e+01	1.6331e+02	-9.2005e-01	2.0946e+03
lnM_{wsv}[DFW_n:nbest5]	7.8327e+00	5.4513e+01	-9.2880e-01	7.1949e+02
lnM_{wsv}[DFW_n:nbest4]	2.1831e+01	1.5800e+02	-8.4989e-01	2.1860e+03

A comparison of the reduced variable day models indicates the best four-variable model (that excluding wind direction variance and temperature variance) outperforms the other two. Furthermore, a comparison with the normalized error metrics in table 19 for M_{wsv}[DFW_d:all] shows the four-variable model yields moderately better NPE_Mean, NPE_StdDev, and NPE_Max values. Its NPE_Min value is more than three times greater; indicating a maximum EDR under-prediction of greater than two compared with significantly less than one. For this reason the four-variable model is not considered a preferable alternative to M_{wsv}[DFW_d:all]. A comparison of the reduced variable night models indicates the best five-variable model (that excluding cloud cover) to significantly outperform the other two in terms of all but the NPE_Min metric, for which it is slightly inferior. A comparison with the normalized error metrics in table 19 for lnM_{wsv}[DFW_n:all], however, indicates this best performing principal candidate model yields slightly better results for all but the NPE_Min metric, for which results are essentially equal. For this reason this best five-variable model is not considered a preferable alternative to lnM_{wsv}[DFW_n:all].

Model Selection

Based on the above evaluation of principal candidate models and related reduced variable models, we recommend a joint use of the identified best day specific and night specific models, M_{wsv}[DFW_d:all] and lnM_{wsv}[DFW_n:all], over the use of that table's best single model alternative, lnM_{wsv}[DFW:all]. We now state the basis for this recommendation and give complete definitions of the model pair, including intercept and term values to eight digits of precision. With each model definition we also provide, for the model intercept and each of its coefficients, its estimated standard error (actual and percent of coefficient), t-statistic for the test that the coefficient is zero, and the p-value for the two-sided t test, as returned by the PV-WAVE® routine ALLBEST. The order of variable inclusion and model R^2 statistic increment and sum are also given. The overall model p-value and coefficient of variation (in percent) are also given. Finally, for each selected model, we provide summaries of the optimal single variable regressions by which optimal term powers were determined, including R^2 and p-value statistics.

Appendices B and C, respectively provide, along with data point definitions of the sets of MEM day and night data sets addressed by the these selected day and night models, the model predicted EDR values for these data points, and actual and data point EDR value normalized model prediction errors, PE.

Basis

The recommendation of two models is based on the following two reasons:

1) The requirements identify day/night status as a candidate variable for explicit inclusion in the model equation. By partitioning the data into separate day and night sets, we avoid regression on the Boolean day/night indicator variable and resulting model discontinuities between day/night boundaries within one large data set, and still capture the essence of this factor.
2) The adoption of the best single model alternative, $\ln M_{wsv}$[DFW:all], allows for gross over-prediction of the anticipated occasional very large daytime EDR values. The limitation of ln(EDR) modeling to the generally lower valued nighttime EDR data points avoids this possibility of non-conservative large EDR overestimation.

We recommend a night model that is trained on and predicts ln(EDR) with wind speed variance weighted regression for four reasons:

1) It provides the best point-wise data EDR normalized mean error of EDR prediction.
2) It provides the best point-wise data EDR normalized standard deviations of EDR error.
3) It provides the best normalized metrics for maximum overestimation by model of EDR.
4) Overestimation does not appear to be a problem at relatively low, nighttime typical, EDR values.

We recommend a day model that is trained on and predicts EDR with wind speed variance weighted regression for two reasons:

1) The day DFW ln(EDR) data trained day model required the incorporation of an artificial upper bound (at the chosen value of 0.015) to avoid gross EDR over-prediction for a single day MEM data point, that having the largest EDR (equal to 1.3516e-02) after filtering.
2) The day DFW EDR data trained model resulted in smaller point-wise data EDR normalized mean and standard deviation error for predicted EDR, and a smaller maximum over-prediction metric.

We recommend wind speed variance weighted models because in all cases they perform better than uniform and wind speed weighted alternatives.

Definitions

Day Model

Equation (5) defines the selected day model for EDR prediction, and table 22 defines the values of its intercept term (C_0) and the coefficients (C_i) and powers (P_i) associated with each of its six regression variable (RV_i) terms, where i=1,6. The symbol “^” denotes exponentiation.

$$EDR = C_0 + \sum_{i=1,6} (C_i * (RV_i \wedge P_i)) \qquad (5)$$

Table 22. Terms, Coefficients, and Powers for the Selected Day EDR Model

Term Description	Subscript (i)	Coefficient (C_i)	Power (P_i)
Intercept	0	1.2361552e+01	Not applicable
Wind speed (RV_1)	1	4.3068828e-07	3.2000e+00
Wind speed variance (RV_2)	2	2.0531805e+01	1.0000e-05
Wind direction variance (RV_3)	3	2.0896215e-05	3.4000e-01
Temperature (RV_4)	4	-3.2889903e+01	2.0000e-05
Temperature variance (RV_5)	5	1.9255064e-05	1.5000e+00
Cloud cover (RV_6)	6	2.3721556e-04	6.5000e-01

Table 23 lists the variables in the order in which they are included in the model. Provided for their corresponding coefficients are; 1) the resulting increment and sum of model R^2, 2) the estimated standard error in terms of actual value and percent of coefficient magnitude (Std Error and %Coeff), 3) the t-statistic, and 4) the p-value. These last three statistics are also provided for the model intercept. The overall model coefficient of variation and p-value are, respectively, 66.26% and zero. Table 24 provides a summary of the near optimal single variable regressions by which term powers were determined, including R^2 and p-value statistics. Figures 41-46 provide optimal power single regression and corresponding residual plots for the model variables in decreasing order of associated R^2 (explained variation strength) as listed in table 24. In the regression plots, the solid line is the least squares fit, while the dashed and dotted lines are, respectively, the 50% and 90% confidence bounds.

Table 23. Variable Inclusion Order, R^2 Growth, & Coefficient/Intercept Statistics for Selected Day EDR Model

Variable Order	R^2 Inc	R^2 Sum	Std Error (%Coeff)	t-statistic	p-value
Wind speed	69.354	69.354	1.1748e-08 (2.728)	3.6660e+01	0.0000e+00
Wind speed variance	0.471	69.825	6.3909e+00 (31.13)	3.2127e+00	1.3646e-03
Temperature	0.133	69.958	1.6044e+01 (48.78)	-2.0499e+00	4.0677e-02
Cloud cover	0.119	70.077	1.2496e-04 (52.68)	1.8983e+00	5.7992e-02
Wind direction variance	0.068	70.145	1.5366e-05 (73.54)	1.3599e+00	1.7422e-01
Temperature variance	0.003	70.148	7.6295e-05 (396.2)	2.5238e-01	8.0081e-01
Intercept			1.6320e+01 (132.0)	7.5747e-01	4.4898e-01

Table 24. Summary of Single Variable Regressions Determining Term Powers for Selected Day EDR Model

Variable	Weighting	Power	R^2	p-value	Meaningful?
wind_spd	wind_spd_var	3.2000e+00	6.92524e+01	0.00000e+00	Yes-dominant
temp	wind_spd_var	2.0000e-05	9.35496e+00	2.67564e-14	Yes-moderate
wind_dir_var	wind_spd_var	3.4000e-01	8.42464e+00	9.10383e-15	Yes-moderate
cld_cvr	wind_spd_var	6.5000e-01	4.23283e+00	1.44183e-09	Yes-weak
wind_spd_var	wind_spd_var	1.0000e-05	3.09354e+00	2.50180e-07	Yes-weak
temp_var	wind_spd_var	1.5000e+00	7.80232e-01	1.00243e-02	Yes-very weak

The difference in the orders of regression variables in tables 23 and 24 indicates that the relative predictive strength (R^2) of a non-dominant variable during single variable regression does not translate directly into increased predictive strength when added to the variable set of the multivariable regression model. Most striking for the selected day model is the much-increased importance of wind speed variance in the multivariable model, moving from fourth to first place among the non-dominant variables. This and the much smaller increases in R^2 growth with the inclusion of additional model variables compared with their independent R^2 values underscores the high degree of correlation between the variables. The monotonic decrease of R^2 increments and the t-statistic with the addition of non-dominant variables, together with the monotonic increase of standard error (in terms of %Coeff) and p-value, demonstrates the effectiveness of the stepwise regression method of creating optimal models of increasing dimension. We point out the observation that the reliability of the model intercept decreases (through larger standard error and p-value statistics) as an additional variable term are added, and approximates the average reliability of all variable terms.

Night Model

Equation (6) defines the selected night model for ln(EDR) prediction and the necessary exponentiation required to recover the model predicted EDR value. Table 25 defines the values of the ln(EDR) model intercept term (C_0) and the coefficients (C_i) and powers (P_i) associated with each of its six regression

variable (RV_i) terms, where i=1,6. The symbol "^" denotes exponentiation and the symbol exp(a) represents e^a.

$$EDR = \exp\left(C_0 + \sum_{i=1,6} (C_i * (RV_i \wedge P_i))\right) \quad (6)$$

Table 25. Terms, Coefficients, and Powers for the Selected Night ln(EDR) Model

Term Description	Subscript (i)	Coefficient (C_i)	Power (P_i)
Intercept	0	3.8288082e+03	Not applicable
Wind speed (RV_1)	1	1.6140513e+01	1.1000e-01
Wind speed variance (RV_2)	2	-3.8559430e+03	2.0000e-05
Wind direction variance (RV_3)	3	1.1325641e-02	5.0000e-01
Temperature (RV_4)	4	-3.2627572e-11	5.1000e+00
Temperature variance (RV_5)	5	-6.6583588e-01	8.3000e-01
Cloud cover (RV_6)	6	-2.2080417e-02	1.0500e+00

Table 26 lists the variables in the order in which they are included in the model. Provided for their corresponding coefficients are; 1) the resulting increment and sum of model R^2, 2) the estimated standard error in terms of actual value and percent of coefficient magnitude (Std Error and %Coeff), 3) the t-statistic, and 4) the p-value. These last three statistics are also provided for the model intercept. The overall model coefficient of variation and p-value are, respectively, 18.92% and zero. Table 27 provides a summary of the near optimal single variable regressions by which term powers were determined, including R^2 and p-value statistics. Figures 47-52 provide optimal power single regression and corresponding residual plots for the model variables in decreasing order of associated R^2 (explained variation strength) as listed in table 27. In the regression plots, the solid line is the least squares fit, while the dashed and dotted lines are, respectively, the 50% and 90% confidence bounds.

Table 26. Variable Inclusion Order, R^2 Growth, & Coefficient/Intercept Statistics for Selected Night ln(EDR) Model

Variable Order	R^2 Inc	R^2 Sum	Std Error (%Coeff)	t-statistic	p-value
Wind speed	43.452	43.452	8.8544e-01 (5.486)	1.8229e+01	0.0000e+00
Temperature variance	2.222	45.674	1.1562e-01 (17.36)	-5.7586e+00	1.2542e-08
Wind direction variance	0.711	46.385	3.3347e-03 (29.44)	3.3963e+00	7.2035e-04
Temperature	0.231	46.616	1.9129e-11 (58.63)	-1.7057e+00	8.8501e-02
Wind speed variance	0.098	46.714	3.4040e+03 (88.28)	-1.1328e+00	2.5768e-01
Cloud cover	0.002	46.716	1.5032e-01 (680.7)	-1.4689e-01	8.8326e-01
Intercept			3.4036e+03 (88.89)	1.1249e+00	2.6099e-01

Table 27. Summary of Single Variable Regressions Determining Term Powers for Selected Night ln(EDR) Model

Variable	Weighting	Power	R^2	p-value	Meaningful?
wind_spd	wind_spd_var	1.1000e-01	4.09723e+01	0.00000e+00	Yes-dominant
wind_dir_var	wind_spd_var	5.0000e-01	1.55263e+01	4.88498e-15	Yes-moderate
temp_var	wind_spd_var	8.3000e-01	1.24008e+01	0.00000e+00	Yes-moderate
cld_cvr	wind_spd_var	1.0500e+00	5.25591e+00	1.05164e-09	Yes-weak
temp	wind_spd_var	5.1000e+00	1.17570e+00	4.29548e-03	Yes-weak
wind_spd_var	wind_spd_var	2.0000e-05	7.56651e-01	2.21120e-02	Yes-very weak

As observed for the selected day model, the selected night model data in tables 26 and 27 demonstrate differences in the relative predictive strengths (R^2) of non-dominant variable during single variable

regression compared with their addition to the night model. Most striking in this case is the decreased importance of cloud cover when introduced into the multivariable model, moving from third to fifth place among the non-dominant variables. The additional observations on the selected day model, regarding high variable correlation, effectiveness of the stepwise regression method and intercept reliability, can also be made for the selected night model.

A comparison of the characteristics of these selected day and night models reveals some significant differences. Most noticeable is the larger predictive power of the day model (R^2=70.148) compared with the night model (R^2=46.716). A comparison of the normalized EDR error metric for these models in table 19 reveals night model metrics are from 35% to 65% larger than those for the day model, manifesting the effectiveness of this increased day model predictive power. The advantage of the selected ln(EDR) predicting night model compared with the alternative EDR predicting alternative (M_{wsv}[DFW_n:all]), also using wind speed variance weighting and having a model R^2=72.667, can be observed by comparing their model term power determining optimal single variable regressions on wind speed, the dominant predictor of EDR. Figure 47 presents the regression and related residual plots for the selected ln(EDR) predicting model. Figure 53 presents the corresponding plots for this alternative, where regression is on EDR, rather than its ln(EDR) representation, over the same night only DFW training set. A regression plot comparison indicates a much better fit by the ln(EDR) model of lower valued EDR for a relatively small reduction in large value EDR fit effectiveness. A comparison of residual plots shows a shift in greater residual spread from the low EDR value (and wind speed) data points when regressing on EDR data to the high EDR value data points when regressing on ln(EDR) data, which indicates improved modeling of low EDR data points relative to points with higher EDR values.

Model Validation

Validation of the selected day and night model pair, respectively defined by linear least squares regression techniques to day and night filtered subsets of the DFW data set, is primarily based on the already presented statistical evaluation of their EDR predictions when applied to day and night filtered subsets of the MEM benchmark evaluation data set, where the same described filtering criteria is universally applied. Validation of these selected day and night specific models is supplemented with similar evaluations of identical model type based intra-DFW models defined on and applied to complementary (and mutually exclusive) train and test portions of the applicable filtered DFW data subsets.

Three nearly equal sized partitions of both the night and day portions of these subsets are formed in a manner that retains similar data point characteristics in each. All three possible combinations of two out of the three day or night data partitions are then used as model train data sets, and the resulting day or night model is applied to the remaining partition serving as the test data set. The shorthand names we use for the resulting six intra-DFW models are identified in the third section of table 15. The three day or night data training sets (partition pairs) are referred to as the complements of their distinct single day or night test partition.

The predictive performance of the three day or night intra-DFW models is compared, and their average performance then compared with that achieved by the full day or night DFW data subset defined model when applied to the corresponding MEM data subset. The former comparison provides an opportunity to gauge the sensitivity of the model training process, while the latter comparison provides a means of assessing the impact of model training and predicting on data sets of different character. A final comparison of intra-DFW model fit error with prediction error provides a means of checking for model over-fitting.

Data Partitioning

We wish the three partitions of the day or night DFW data subset to be statistically similar, yet reflect the characteristics of the entire subset. Given the knowledge that DFW data represents measurements taken during AVOSS deployments in different seasons of the year, and that EDR measurements possess a cyclic trend over the time of day, we desire an equal but random representation of data points obtained at specific months of the year and hours of the day (or night) in all three day (or night) partitions. We also wish the partitions to be equal or nearly equal in size. This is achieved by first ordering the day and night data subsets by the hour field within the month field, and then randomizing data point order within each subset of matching month and hour. The desired partitioning can then be achieved by simply dealing these reordered data points in sequence to the three partitions of the day or night subset; the first and fourth to partition 1, the second and fifth to partition 2, and the third and sixth to partition 3 etc. Dealing ensures partition sizes will differ by no more than one, the random ordering within matching month and hour subsets ensures statistical similarity, and the preliminary ordering of these subsets ensures an equal representation of month and hour of day specific data points.

Application of this partitioning technique to the filtered subsets of day and night DFW data resulted in the three partitions, DFW_{d1}, DFW_{d2}, and DFW_{d3}, of day data, and the three partitions, DFW_{n1}, DFW_{n2}, and DFW_{n3}, of night data. Table 28 provides a comparison of partition sizes and their data EDR value statistics. Sizes among the three partitions of day and night data are seen to be as close to equal as possible given the totals of 856 day and 730 night data points [table 5]. The day partition EDR statistics compare reasonably well, as also do those for the night partitions, although with moderate increase in variation. This indicates similar distributions of EDR magnitudes among the day partitions, and among the night partitions.

Table 28. A Comparison of Day and Night DFW Partition Sizes and EDR Statistics

Partition	Size	Mean	StdDev	Min	Max
DFW_{d1}	286	1.9716e-03	1.6917e-03	0.0000e+00	1.0723e-02
DFW_{d2}	285	2.0762e-03	1.9178e-03	4.0000e-05	1.0500e-02
DFW_{d3}	285	2.0421e-03	1.7787e-03	1.7110e-05	1.1640e-02
DFW_{n1}	244	1.6374e-03	1.7389e-03	0.0000e+00	1.0863e-02
DFW_{n2}	243	1.9562e-03	2.3043e-03	0.0000e+00	1.2920e-02
DFW_{n3}	243	1.7262e-03	1.8262e-03	1.8700e-06	1.0337e-02

A comparison among day partitions of numbers of data points with equal month and hour fields in the day partitions verified the desired similarity. This was also found to be true among the night partitions. Both sets of partitions also exhibited similarity of distribution with respect to year and day of month.

Model Performance

The day intra-DFW validation models identified in table 15 were developed by the same method used for the selected day model, defined by equation (5) and table 22. The same basic model type, M_{wsv}, was the basis, but the parameter estimation (training) data set determining the model intercept and term optimal powers and coefficients was different in each case, specifically the complement, with respect to the entire day data subset, of the data partition on which the model was tested. An equivalent statement can be made for the night intra-DFW validation models identified in table 15, where the basic model type used is $\ln M_{wsv}$, that used to develop the selected night model, defined by equation (6) and table 25. Table 29 summarizes the estimation and testing of these intra-DFW validation models.

Table 29. Summary of Intra-DFW Validation Model Type, Training, and Testing

Model	Basic Model Type	Training Data Set	Test Data Set
$M_{wsv}[DFW_d^1:all]$	M_{wsv}	DFW_d^1 = { DFW_{d2}, DFW_{d3})	DFW_{d1}
$M_{wsv}[DFW_d^2:all]$	M_{wsv}	DFW_d^2 = { DFW_{d1}, DFW_{d3})	DFW_{d2}
$M_{wsv}[DFW_d^3:all]$	M_{wsv}	DFW_d^3 = { DFW_{d1}, DFW_{d2})	DFW_{d3}
$lnM_{wsv}[DFW_n^1:all]$	lnM_{wsv}	DFW_n^1 = { DFW_{n2}, DFW_{n3})	DFW_{n1}
$lnM_{wsv}[DFW_n^2:all]$	lnM_{wsv}	DFW_n^2 = { DFW_{n1}, DFW_{n3})	DFW_{n2}
$lnM_{wsv}[DFW_n^3:all]$	lnM_{wsv}	DFW_n^3 = { DFW_{n1}, DFW_{n2})	DFW_{n3}

Point-wise, test data EDR normalized, error (NPE) metrics of model predicted EDR for each of the three day and night validation models is presented in table 30, along with error metric averages over all day/night validation models and a repetition of the NPE metrics for the selected day/night models when addressing the MEM day/night subsets, MEM_d/MEM_n, given in table 19.

Table 30. NPE Based Comparison of Intra-DFW Model Performance with Selected Models Addressing MEM Data

Model	Test Data Set	NPE_Mean	NPE_StdDev	NPE_Min	NPE_Max
Day Models					
$M_{wsv}[DFW_d^1:all]$	DFW_{d1}	2.0597e+00	2.3645e+01	-8.3552e-01	3.9655e+02
$M_{wsv}[DFW_d^2:all]$	DFW_{d2}	6.3493e-01	3.0582e+00	-6.9500e-01	3.9507e+01
$M_{wsv}[DFW_d^3:all]$	DFW_{d3}	5.4735e-01	4.8808e+00	-9.5737e-01	7.9433e+01
Average		1.0807e+00	1.0528e+01	-8.2930e-01	1.7183e+02
$M_{wsv}[DFW_d:all]$	MEM_d	4.8385e+00	3.7540e+01	-6.9572e-01	4.3191e+02
Night Models					
$lnM_{wsv}[DFW_n^1:all]$	DFW_{n1}	1.9791e+00	1.5684e+01	-9.3134e-01	1.8652e+02
$lnM_{wsv}[DFW_n^2:all]$	DFW_{n2}	3.0294e+00	2.1573e+01	-9.9856e-01	2.4586e+02
$lnM_{wsv}[DFW_n^3:all]$	DFW_{n3}	2.2825e+00	1.3123e+01	-9.9857e-01	1.5980e+02
Average		2.4303e+00	1.6793e+01	-9.7616e-01	1.9739e+02
$lnM_{wsv}[DFW_n:all]$	MEM_n	7.8113e+00	5.4334e+01	-9.2928e-01	7.1566e+02

The last two rows of day model NPE metrics indicate that the average ability of the intra-DFW day models, formulated and evaluated over the three pairs of complementary DFW train/test data sets, to predict EDR is approximately four times better, based on NPE_Mean and NPE_StdDev ratios, than that of the selected day model, estimated (trained) on the full subset of DFW day data, when applied to MEM day data. For example, the ratio of the NPE_Mean for $M_{wsv}[DFW_d:all]$ on MEM_d over the average NPE_Mean for all three intra-DFW day models on their respective test data sets is 4.8385/1.0807 or 4.4772, while the corresponding ratio of NPE_StdDev values is 37.540/10.528 or 3.5657. The corresponding ratios for the NPE_Max and NPE_Min metrics have reduced values of approximately 2.5 and near one, respectively, indicating less difference in maximum EDR over-prediction and essentially no difference in EDR under-prediction. An examination of the corresponding night model NPE_Mean and NPE_StdDev ratios, both approximately equal to 3.2, identifies only a slight reduction in improved intra-DFW night model performance compared with that of the selected night model when applied to MEM night data.

These ratios demonstrate that the error in EDR predictions by the selected day and night models trained on the full DFW data day and night subsets will increase as the character of the data set for which predictions are made diverges from that of the DFW data set. To the extent that the MEM data set represents a typical difference in character from that of the DFW data set, the NPE metrics for EDR prediction errors of these models when addressing data of other airport sites, such as those listed in table

2, are expected to be three to four times greater than those demonstrated by the average intra-DFW model validation tests as presented in table 30.

Figures 54-56 present plot pairs of predicted EDR (EDR˜) versus data EDR and PE for each of the three intra-DFW day model validation tests. The order of data points in these plots, labeled as chronological, is so ordered with respect to year, month, and hour, but random within all equal hour subsets with respect to day of month and minute of hour (either 0 or 30). An examination of these three plot pairs indicates EDR versus EDR˜ distributions by plot type among pairs to be similar, with larger magnitudes and somewhat increased variability for EDR and EDR˜ compared with the corresponding plot (figure 30) for the selected day model when applied to MEM day data, as reflected in the summary day data distribution statistics of table 7. The associated PE plots, however, all show larger magnitude but more symmetric distributions.

Figures 57-59 present similar plots for each of the three intra-DFW night model validation tests. A comparison of these three plot pairs indicates a reduced similarity in EDR versus EDR˜ distributions. The magnitudes of their EDR and EDR˜ distributions, compared with those in the corresponding plot (figure 36) for the selected night model when applied to MEM night data, demonstrate an even greater disparity in magnitude as reflected in the summary night data distribution statistics of table 7. The EDR˜ also identify a reduction in negative bias compared with the day model predicted EDR˜ for MEM day data, as is clearly demonstrated by a comparison of corresponding PE distributions.

Model Fit

As previously mentioned, reference 9 states that over-modeling of the parameter estimation data set, while reducing estimation error, will generally lead to a larger prediction error when applied to a distinct test data set. A check on over-modeling of the intra-DFW validation models to their estimation data sets can be made by comparing the model fit error, equivalent to predicting EDR on the estimation data set, with model prediction error. Given the observed similarity in character of the complementary estimation and test subsets, over-training would be identified by model prediction error significantly larger than model fit error.

Table 31 presents NPE metrics of model fit determined EDR, or EDR˜ on the estimation data set, for each of the three day and night validation models, along with their averages over all day or night validation models. Figures 60-62 present plot pairs of fit EDR (EDR˜) versus data EDR and PE for each of the three intra-DFW day models. The order of data points in these plots, labeled as chronological, is so ordered with respect to year, month, and hour, but random within all equal hour subsets with respect to day of month and minute of hour (either 0 or 30).

Table 31. NPE Based Summary of Intra-DFW Model Fit EDR Error (Where Training Set Equals Test Set)

Model	Test Data Set	NPE_Mean	NPE_StdDev	NPE_Min	NPE_Max
Day Models					
$M_{wsv}[DFW_d^1:all]$	DFW_d^1	5.8168e-01	3.9444e+00	-8.5637e-01	7.5015e+01
$M_{wsv}[DFW_d^2:all]$	DFW_d^2	1.3871e+00	1.6329e+01	-8.7338e-01	3.7640e+02
$M_{wsv}[DFW_d^3:all]$	DFW_d^3	1.2362e+00	1.6669e+01	-8.9216e-01	3.9258e+02
Average		1.0683E+00	1.2314E+01	-8.7397E-01	2.8133E+02
Night Models					
$lnM_{wsv}[DFW_n^1:all]$	DFW_n^1	2.9405e+00	2.3176e+01	-9.7121e-01	4.0145e+02
$lnM_{wsv}[DFW_n^2:all]$	DFW_n^2	1.4318e+00	9.2871e+00	-9.9859e-01	1.5122e+02
$lnM_{wsv}[DFW_n^3:all]$	DFW_n^3	2.1632e+00	1.7903e+01	-9.9790e-01	2.8587e+02
Average		2.1785E+00	1.6789E+01	-9.8923E-01	2.7951E+02

A comparison of these figures with figures 54-56 demonstrates that the distributions and characteristics of day models fit error and prediction error are similar, although the fit error plots, figures 60-62, address twice as many data points (a pair of the three DFW day data partitions). Figures 63-65 present similar plots for each of the three intra-DFW night models. A comparison of these figures with figures 57-59 demonstrate the distributions and characteristics of day model fit error and prediction error are also similar, but with double the number of data points again represented in figures 63-65.

Table 32 presents, for both day and night intra-DFW model sets, the ratios of the average EDR prediction NPE metrics presented in table 30 over the average EDR fit NPE metrics presented in table 31. We observe that these ratios are all of order one, indicating no great statistical difference between point-wise, data EDR normalized, EDR prediction and fit errors. This is evidence that the method we have used to define the day and night intra-DFW models, and the selected day and night models based on the entire day and night subsets of DFW data, produce EDR predictors that do not significantly over-model their training data sets.

Table 32. Prediction Over Fit Ratios of NPE metrics for Average Day and Night Intra-DFW Models

Model Set	NPE_Mean Ratio	NPE_StdDev Ratio	NPE_Min Ratio	NPE_Max Ratio
Day Intra-DFW	1.0116E+00	8.5496E-01	9.4889E-01	6.1078E-01
Night Intra-DFW	1.1156E+00	1.0002E+00	9.8679E-01	7.0620E-01

Ratio values of greater than one indicate prediction error, in terms of the addressed metric, to be greater than fit error. Under the presumption that estimation and test data sets are similar in character, ratio values larger than one are an indicator of over-modeling. The NPE_Mean and NPE_StdDev measures are the primary evaluation metrics respectively representing model bias and goodness of fit. Their ratios for both day and night intra-DFW models approximate unity, indicating that these models predict, within the DFW data set, about as well as they fit their model estimation data. This indicates that over-modeling of estimation data has not occurred, and suggests that the similarly developed selected day and night models, based on all DFW day and night data, can be expected to predict EDR on other test data sets to the same level of accuracy exhibited by the model fit, provided those test data sets exhibits characteristics similar to that of the DFW data set.

The generally larger ratios for the night intra-DFW models, compared with their day counterparts, suggest a relatively better model fit of night data, compared with night model predictive ability, than that achieved by the day model on the day data. While the reason for this is not entirely understood, the demonstrated lower predictive power of the ln(EDR) fitting night basic model type, compared with the EDR fitting day basic model type, can be expected to yield relatively poorer EDR prediction for the night models. Based on the presumption that models of these basic types are equally well fitted to their defining data, the poorer prediction performance of the night model, quantified by the relatively lower value of its explained variation statistic, R^2, would lead to the higher observed ratios of prediction over fit error.

Summary and Conclusions

Summary

- As a basis for defining and evaluating effective first order Eddy Dissipation Rate (EDR) prediction models, representative weather profile data sets, consisting of 30-minute forward averaged mean and variance reductions of raw measurements, have been created for the Dallas/Fort Worth (DFW) and Memphis (MEM) international airport sites, based on data collected during 1997-2000 DFW and 1994-1995 MEM AVOSS deployments.

- Additional full year 1999 sets of similarly reduced ASOS data have been created for 12 major continental United States airports, including DFW but not MEM, for further evaluation of the general predictive capability of such models.
- Effective first order mean EDR prediction by a least squares based multivariable linear regression model trained on and applied to meteorological data from different localities has been demonstrated, by training on 1997-2000 DFW data and application to 1994-1995 MEM data.
- The performance metric used for assessing model EDR prediction is point-wise, data EDR normalized, model (predicted) minus data (measured) EDR.
- Regression weighting emphasizing data point variables with high variance is successfully addressed. Regression weighting emphasizing data point variables with low variance is not addressed.
- Separate estimation and application of alternative model forms to day and night specific data is demonstrated to be desirable, based on model development and evaluation using the above data sets. A single pair of EDR prediction models, respectively addressing day and night data, has been defined, and represents the best performing day and night model combination among evaluated alternatives.
- EDR predictions by selected models demonstrate a negative bias for larger EDR values, known to lead to conservative (low) estimates of vortex dissipation rate, and a smaller positive bias for smaller EDR values.
- The model prediction method is validated by demonstrating a reduction of EDR error by a factor of three to four when estimating and fitting to representative complementary subsets of DFW data, that is subsets with similar characteristics, and demonstrates the potential of the selected model pair for improved prediction accuracy when applying to data sets of a character similar to the DFW data set.
- A good level of model fit, indicating the absence of over-training, is demonstrated by observing near equal sized model fit and prediction mean EDR errors when addressing complementary and representative model train and test subsets of DFW data.

Conclusions

- For the addressed data, single, wind speed variance weighted, model terms of an optimal power constitute the most desirable model form for training, that is, model form intercept and term coefficient determination by a minimum least squares based multivariable linear regression. Model terms for the meteorological variables of wind speed, wind speed variation, wind direction variation, temperature, temperature variation, and cloud cover are desired, while terms for wind direction, dew point, and dew point variation are not. Optimal term powers are determined by maximizing the explained variation realized during single variable regression on the variable represented by the term.
- The demonstration of a significantly different (local) time dependency of EDR within DFW and MEM data sets, and the potential for its existence among geographically disperse airport sites, rules out local time of day as an effective model regression variable.
- The use of separate prediction models on day and night only data is an effective method of including the predictive potential of the day/night indicator data variable without introducing model discontinuity.
- A high level of correlation among the meteorological variables selected for representation in EDR models; limits their predictive power (explained variation) relative to the sum of their single variable predictive powers in isolation, affects the composition of variable subsets for best models of reduced dimension, and can lead to significant precision losses in model predictions.
- The potential mitigation, by use of best lower dimensional alternatives, of the inherent significant precision losses associated with the identified best full variable models does not result in significant prediction improvement.
- The coefficients used in the developed regression models for predicting EDR must be of sufficient precision to ensure accurate EDR values. For the models developed, coefficients with eight digits of precision are required to ensure EDR value accuracy retention to three digits of precision.

- The poor predictive performance of reduced variable models not employing terms for variance in wind speed, wind direction, and temperature, demonstrate the necessity of variance measures in the application data set. The significant increase in explained variation for the wind speed model term when weighted by its variation, identify wind speed variance as critical to optimal EDR prediction.
- Given its increased emphasis on smaller EDR values, modeling the natural log of EDR when addressing night data demonstrates an improved ability to predict generally lower (night typical) EDR, but not necessarily typical higher daytime EDR for which gross over prediction may occur.
- The markedly poorer EDR prediction of selected DFW data trained models when addressing MEM data, compared with similar models trained and applied to distinct sets of similar character (e.g. complementary subsets of DFW data), demonstrates the potential for degradation of their EDR predictions, when applied to meteorological data representing a new locality. Furthermore, the extent of this degradation is expected to correlate directly with any increased difference in character of that locality's data with respect to the DFW model training data.

Appendix A

Data points filtered out of the DFW data set

The data points filtered out of the DFW data set are identified by data point index, date time stamp fields, and the reason for removal. The index identifies the position of the data point in the chronologically ordered set of total data points.

Index	Year	Month	Day	Hour	Min	Reason for Removal	(RV value > RV bound)
13	1997	9	15	6	0	zero wind_spd_var	
27	1997	9	15	13	0	wind_spd_var > bnd	(9.20000e+00 > 8.00000e+00)
95	1997	9	16	23	0	missing data	
96	1997	9	16	23	30	missing data	
97	1997	9	17	0	0	missing data	
98	1997	9	17	0	30	missing data	
99	1997	9	17	1	0	missing data	
100	1997	9	17	1	30	missing data	
101	1997	9	17	2	0	missing data	
102	1997	9	17	2	30	missing data	
172	1997	9	18	13	30	wind_spd_var > bnd	(8.16700e+00 > 8.00000e+00)
173	1997	9	18	14	0	wind_spd_var > bnd	(1.01670e+01 > 8.00000e+00)
193	1997	9	19	0	0	zero wind_spd_var	
243	1997	9	20	1	0	missing data	
244	1997	9	20	1	30	zero wind_spd_var	
251	1997	9	20	5	0	missing data	
252	1997	9	20	5	30	missing data	
253	1997	9	20	6	0	missing data	
254	1997	9	20	6	30	missing data	
255	1997	9	20	7	0	missing data	
256	1997	9	20	7	30	missing data	
257	1997	9	20	8	0	missing data	
258	1997	9	20	8	30	missing data	
259	1997	9	20	9	0	missing data	
260	1997	9	20	9	30	missing data	
271	1997	9	20	15	0	wind_spd_var > bnd	(1.60000e+01 > 8.00000e+00)
276	1997	9	20	17	30	wind_spd_var > bnd	(9.36700e+00 > 8.00000e+00)
277	1997	9	20	18	0	missing data	
278	1997	9	20	18	30	missing data	
286	1997	9	20	22	30	missing data	
287	1997	9	20	23	0	missing data	
288	1997	9	20	23	30	missing data	
289	1997	9	21	0	0	missing data	
290	1997	9	21	0	30	missing data	
291	1997	9	21	1	0	missing data	
292	1997	9	21	1	30	missing data	
293	1997	9	21	2	0	missing data	
294	1997	9	21	2	30	missing data	
295	1997	9	21	3	0	missing data	
296	1997	9	21	3	30	zero wind_spd_var	
325	1997	9	21	18	0	missing data	
326	1997	9	21	18	30	missing data	
327	1997	9	21	19	0	wind_spd_var > bnd	(9.46700e+00 > 8.00000e+00)
352	1997	9	22	7	30	missing data	
353	1997	9	22	8	0	missing data	
354	1997	9	22	8	30	missing data	
355	1997	9	22	9	0	missing data	
359	1997	9	22	11	0	temp_var > bnd	(4.84371e+05 > 4.00000e+00)
372	1997	9	22	17	30	temp_var > bnd	(7.02000e+00 > 4.00000e+00)
381	1997	9	22	22	0	missing data	
382	1997	9	22	22	30	missing data	
389	1997	9	23	2	0	zero wind_spd_var	
484	1997	9	25	1	30	missing data	
485	1997	9	25	2	0	missing data	
486	1997	9	25	2	30	missing data	

Index	Year	Month	Day	Hour	Min	Reason for Removal	(RV value >	RV bound)
487	1997	9	25	3	0	missing data		
488	1997	9	25	3	30	missing data		
489	1997	9	25	4	0	missing data		
490	1997	9	25	4	30	missing data		
491	1997	9	25	5	0	missing data		
492	1997	9	25	5	30	missing data		
493	1997	9	25	6	0	missing data		
494	1997	9	25	6	30	missing data		
495	1997	9	25	7	0	missing data		
496	1997	9	25	7	30	missing data		
497	1997	9	25	8	0	missing data		
498	1997	9	25	8	30	missing data		
499	1997	9	25	9	0	missing data		
500	1997	9	25	9	30	missing data		
501	1997	9	25	10	0	missing data		
502	1997	9	25	10	30	missing data		
535	1997	9	26	3	0	missing data		
536	1997	9	26	3	30	missing data		
541	1997	9	26	6	0	missing data		
555	1997	9	26	13	0	wind_spd_var > bnd	(8.26700e+00 >	8.00000e+00)
565	1997	9	26	18	0	missing data		
566	1997	9	26	18	30	missing data		
567	1997	9	26	19	0	missing data		
572	1997	9	26	21	30	missing data		
573	1997	9	26	22	0	missing data		
574	1997	9	26	22	30	missing data		
575	1997	9	26	23	0	missing data		
576	1997	9	26	23	30	missing data		
577	1997	9	27	0	0	missing data		
578	1997	9	27	0	30	missing data		
579	1997	9	27	1	0	missing data		
580	1997	9	27	1	30	missing data		
581	1997	9	27	2	0	missing data		
582	1997	9	27	2	30	missing data		
583	1997	9	27	3	0	missing data		
584	1997	9	27	3	30	missing data		
585	1997	9	27	4	0	missing data		
586	1997	9	27	4	30	missing data		
587	1997	9	27	5	0	missing data		
588	1997	9	27	5	30	missing data		
589	1997	9	27	6	0	missing data		
623	1997	9	27	23	0	missing data		
624	1997	9	27	23	30	missing data		
635	1997	9	28	5	0	zero wind_spd_var		
654	1997	9	28	14	30	wind_spd_var > bnd	(1.02670e+01 >	8.00000e+00)
672	1997	9	28	23	30	zero wind_spd_var		
676	1997	9	29	1	30	zero wind_spd_var		
682	1997	9	29	4	30	zero wind_spd_var		
684	1997	9	29	5	30	zero wind_spd_var		
686	1997	9	29	6	30	zero wind_spd_var		
706	1997	9	29	16	30	wind_spd_var > bnd	(1.06670e+01 >	8.00000e+00)
711	1997	9	29	19	0	temp_var > bnd	(1.47960e+01 >	4.00000e+00)
712	1997	9	29	19	30	missing data		
717	1997	9	29	22	0	temp_var > bnd	(4.75200e+00 >	4.00000e+00)
751	1997	9	30	15	0	missing data		
752	1997	9	30	15	30	missing data		
758	1997	9	30	18	30	zero wind_spd_var		
763	1997	9	30	21	0	zero wind_spd_var		
782	1997	10	1	6	30	zero wind_spd_var		
785	1997	10	1	8	0	wind_spd_var > bnd	(1.12000e+01 >	8.00000e+00)
787	1997	10	1	9	0	missing data		
788	1997	10	1	9	30	missing data		
789	1997	10	1	10	0	missing data		
790	1997	10	1	10	30	missing data		
791	1997	10	1	11	0	missing data		
792	1997	10	1	11	30	missing data		
793	1997	10	1	12	0	missing data		
794	1997	10	1	12	30	missing data		
795	1997	10	1	13	0	missing data		

Index	Year	Month	Day	Hour	Min	Reason for Removal (RV value > RV bound)
820	1997	10	2	1	30	missing data
821	1997	10	2	2	0	missing data
822	1997	10	2	2	30	missing data
823	1997	10	2	3	0	missing data
824	1997	10	2	3	30	missing data
825	1997	10	2	4	0	missing data
826	1997	10	2	4	30	missing data
827	1997	10	2	5	0	missing data
828	1997	10	2	5	30	missing data
829	1997	10	2	6	0	missing data
830	1997	10	2	6	30	missing data
831	1997	10	2	7	0	missing data
832	1997	10	2	7	30	missing data
833	1997	10	2	8	0	missing data
834	1997	10	2	8	30	missing data
835	1997	10	2	9	0	missing data
836	1997	10	2	9	30	missing data
837	1997	10	2	10	0	missing data
838	1997	10	2	10	30	missing data
839	1997	10	2	11	0	missing data
840	1997	10	2	11	30	missing data
841	1997	10	2	12	0	missing data
842	1997	10	2	12	30	missing data
843	1997	10	2	13	0	missing data
844	1997	10	2	13	30	missing data
893	1997	10	3	14	0	missing data
894	1997	10	3	14	30	missing data
906	1997	10	3	20	30	missing data
907	1997	10	3	21	0	missing data
908	1997	10	3	21	30	missing data
909	1997	10	3	22	0	missing data
910	1997	10	3	22	30	missing data
911	1997	10	3	23	0	missing data
912	1997	10	3	23	30	missing data
913	1999	11	15	0	0	missing data
914	1999	11	15	0	30	missing data
915	1999	11	15	1	0	missing data
916	1999	11	15	1	30	missing data
917	1999	11	15	2	0	missing data
918	1999	11	15	2	30	missing data
919	1999	11	15	3	0	missing data
920	1999	11	15	3	30	missing data
921	1999	11	15	4	0	missing data
922	1999	11	15	4	30	missing data
923	1999	11	15	5	0	missing data
924	1999	11	15	5	30	missing data
925	1999	11	15	6	0	missing data
926	1999	11	15	6	30	missing data
927	1999	11	15	7	0	missing data
928	1999	11	15	7	30	missing data
929	1999	11	15	8	0	missing data
930	1999	11	15	8	30	missing data
931	1999	11	15	9	0	missing data
932	1999	11	15	9	30	missing data
933	1999	11	15	10	0	missing data
934	1999	11	15	10	30	missing data
935	1999	11	15	11	0	missing data
936	1999	11	15	11	30	missing data
937	1999	11	15	12	0	missing data
938	1999	11	15	12	30	missing data
939	1999	11	15	13	0	missing data
940	1999	11	15	13	30	missing data
941	1999	11	15	14	0	missing data
942	1999	11	15	14	30	missing data
943	1999	11	15	15	0	missing data
944	1999	11	15	15	30	missing data
945	1999	11	15	16	0	missing data
946	1999	11	15	16	30	missing data
947	1999	11	15	17	0	missing data

Index	Year	Month	Day	Hour	Min	Reason for Removal	(RV value >	RV bound)
948	1999	11	15	17	30	missing data		
1029	1999	11	17	10	0	temp_var > bnd	(4.85500e+00 >	4.00000e+00)
1030	1999	11	17	10	30	temp_var > bnd	(4.05100e+00 >	4.00000e+00)
1033	1999	11	17	12	0	zero wind_spd_var		
1041	1999	11	17	16	0	missing data		
1042	1999	11	17	16	30	missing data		
1081	1999	11	18	12	0	missing data		
1082	1999	11	18	12	30	missing data		
1085	1999	11	18	14	0	missing data		
1086	1999	11	18	14	30	missing data		
1092	1999	11	18	17	30	missing data		
1093	1999	11	18	18	0	missing data		
1133	1999	11	19	14	0	missing data		
1134	1999	11	19	14	30	missing data		
1157	1999	11	30	2	0	zero wind_spd_var		
1164	1999	11	30	5	30	EDR > upper bound	(2.23133e-02 >	1.36000e-02)
1165	1999	11	30	6	0	missing data		
1166	1999	11	30	6	30	missing data		
1167	1999	11	30	7	0	missing data		
1168	1999	11	30	7	30	missing data		
1169	1999	11	30	8	0	missing data		
1170	1999	11	30	8	30	missing data		
1171	1999	11	30	9	0	missing data		
1172	1999	11	30	9	30	missing data		
1173	1999	11	30	10	0	missing data		
1174	1999	11	30	10	30	missing data		
1175	1999	11	30	11	0	missing data		
1176	1999	11	30	11	30	missing data		
1177	1999	11	30	12	0	missing data		
1178	1999	11	30	12	30	missing data		
1179	1999	11	30	13	0	missing data		
1180	1999	11	30	13	30	missing data		
1181	1999	11	30	14	0	missing data		
1182	1999	11	30	14	30	missing data		
1183	1999	11	30	15	0	missing data		
1211	1999	12	1	5	0	EDR > upper bound	(1.81767e-02 >	1.36000e-02)
1214	1999	12	1	6	30	missing data		
1215	1999	12	1	7	0	missing data		
1216	1999	12	1	7	30	missing data		
1217	1999	12	1	8	0	missing data		
1218	1999	12	1	8	30	missing data		
1219	1999	12	1	9	0	missing data		
1220	1999	12	1	9	30	missing data		
1221	1999	12	1	10	0	missing data		
1222	1999	12	1	10	30	missing data		
1223	1999	12	1	11	0	missing data		
1224	1999	12	1	11	30	missing data		
1225	1999	12	1	12	0	missing data		
1226	1999	12	1	12	30	missing data		
1227	1999	12	1	13	0	missing data		
1228	1999	12	1	13	30	missing data		
1229	1999	12	1	14	0	missing data		
1230	1999	12	1	14	30	missing data		
1243	1999	12	1	21	0	wind_spd_var > bnd	(1.10100e+01 >	8.00000e+00)
1281	1999	12	2	16	0	missing data		
1284	1999	12	2	17	30	missing data		
1285	1999	12	2	18	0	missing data		
1286	1999	12	2	18	30	zero wind_spd_var		
1287	1999	12	2	19	0	missing data		
1288	1999	12	2	19	30	missing data		
1289	1999	12	2	20	0	zero wind_spd_var		
1296	1999	12	2	23	30	wind_spd_var > bnd	(9.39000e+00 >	8.00000e+00)
1306	1999	12	3	4	30	EDR > upper bound	(1.36400e-02 >	1.36000e-02)
1314	1999	12	3	8	30	missing data		
1315	1999	12	3	9	0	missing data		
1316	1999	12	3	9	30	missing data		
1317	1999	12	3	10	0	missing data		
1318	1999	12	3	10	30	missing data		
1319	1999	12	3	11	0	missing data		

Index	Year	Month	Day	Hour	Min	Reason for Removal	(RV value >	RV bound)
1320	1999	12	3	11	30	missing data		
1321	1999	12	3	12	0	missing data		
1322	1999	12	3	12	30	missing data		
1323	1999	12	3	13	0	missing data		
1324	1999	12	3	13	30	missing data		
1325	1999	12	3	14	0	missing data		
1326	1999	12	3	14	30	missing data		
1327	1999	12	3	15	0	missing data		
1368	2000	6	21	11	30	dewpt > temp	(8.24000e+01 >	7.90000e+01)
1381	2000	6	21	18	0	temp_var > bnd	(7.73500e+00 >	4.00000e+00)
1391	2000	6	21	23	0	EDR > upper bound	(1.71867e-02 >	1.36000e-02)
1392	2000	6	21	23	30	EDR > upper bound	(1.36767e-02 >	1.36000e-02)
1416	2000	6	22	11	30	dewpt > temp	(7.89000e+01 >	7.39000e+01)
1429	2000	6	22	18	0	missing data		
1430	2000	6	22	18	30	missing data		
1431	2000	6	22	19	0	missing data		
1432	2000	6	22	19	30	missing data		
1435	2000	6	22	21	0	missing data		
1436	2000	6	22	21	30	missing data		
1441	2000	6	23	0	0	missing data		
1442	2000	6	23	0	30	missing data		
1464	2000	6	23	11	30	dewpt > temp	(8.08000e+01 >	7.80000e+01)
1822	2000	7	19	22	30	missing data		
1823	2000	7	19	23	0	missing data		

Appendix B

Data point definitions and model EDR predictions for the MEM day data subset

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
1	1995	8	6	18	30	6.9000e+00	4.8000e-01	6.3695e+02	8.6400e+01	5.1000e-02	0.0000e+00	2.3444e-03	7.6639e-04	-1.5781e-03	-6.7310e-01
2	1995	8	6	19	0	6.6000e+00	1.2000e+00	4.6665e+02	8.6600e+01	1.5100e-01	3.1250e-01	1.4740e-03	1.0156e-03	-4.5847e-04	-3.1103e-01
3	1995	8	6	19	30	7.9000e+00	1.6000e+00	2.3890e+01	8.6700e+01	1.3100e-01	3.1250e-01	8.9739e-04	1.1071e-03	2.0975e-04	2.3374e-01
4	1995	8	6	20	0	9.0000e+00	1.3400e+00	9.6490e+01	8.7200e+01	1.4300e-01	3.1250e-01	1.3207e-03	1.2726e-03	-4.8070e-05	-3.6398e-02
5	1995	8	6	20	30	1.1000e+01	1.7700e+00	1.6413e+02	8.7700e+01	1.7400e-01	3.1250e-01	2.4622e-03	1.7837e-03	-6.7853e-04	-2.7558e-01
6	1995	8	6	21	0	1.0800e+01	1.4700e+00	9.2460e+01	8.7500e+01	6.8000e-02	7.5000e-01	1.6727e-03	1.7590e-03	8.6316e-05	5.1604e-02
7	1995	8	6	21	30	9.8000e+00	1.9400e+00	9.4630e+01	8.7600e+01	6.4000e-02	7.5000e-01	1.5515e-03	1.5851e-03	3.3571e-05	2.1637e-02
8	1995	8	6	22	0	9.0000e+00	1.2200e+00	4.9400e+01	8.7700e+01	4.7000e-02	3.1250e-01	1.2788e-03	1.2281e-03	-5.0642e-05	-3.9601e-02
9	1995	8	6	22	30	1.0100e+01	6.7700e+00	7.4766e+02	8.6300e+01	3.2400e+00	3.1250e-01	3.8244e-03	2.0390e-03	-1.7854e-03	-4.6685e-01
10	1995	8	6	23	0	8.2000e+00	1.4400e+00	3.4630e+01	8.4100e+01	8.0000e-03	7.5000e-01	1.9889e-03	1.2406e-03	-7.4835e-04	-3.7626e-01
11	1995	8	6	23	30	5.9000e+00	7.3000e-01	3.8500e+01	8.3800e+01	1.8000e-02	7.5000e-01	1.2017e-03	8.7080e-04	-3.3090e-04	-2.7536e-01
12	1995	8	7	0	0	6.2000e+00	1.2900e+00	2.7030e+01	8.2300e+01	4.6500e-01	7.5000e-01	8.0527e-04	1.0184e-03	2.1311e-04	2.6465e-01
13	1995	8	7	0	30	4.0000e+00	8.2000e-01	7.4360e+01	8.0700e+01	1.1500e-01	7.5000e-01	5.2762e-04	8.4786e-04	3.2024e-04	6.0694e-01
14	1995	8	7	11	0	6.5000e+00	3.2000e-01	1.2970e+01	7.6700e+01	1.1000e-02	7.5000e-01	9.5580e-04	7.8418e-04	-1.7162e-04	-1.7956e-01
15	1995	8	7	11	30	6.7000e+00	3.3000e-01	1.1520e+01	7.6700e+01	1.5000e-02	7.5000e-01	7.5140e-04	8.0585e-04	5.4450e-05	7.2465e-02
16	1995	8	7	12	0	7.7000e+00	1.0000e+00	9.0800e+00	7.7600e+01	1.3000e-01	3.1250e-01	1.0525e-03	1.0436e-03	-8.8705e-06	-8.4278e-03
17	1995	8	7	12	30	8.8000e+00	1.3600e+00	4.4140e+01	7.8800e+01	1.5000e-01	3.1250e-01	1.7333e-03	1.2849e-03	-4.4843e-04	-2.5871e-01
18	1995	8	7	13	0	9.7000e+00	1.5500e+00	5.6470e+01	7.9700e+01	3.8000e-02	3.1250e-01	1.9076e-03	1.4754e-03	-4.3216e-04	-2.2655e-01
19	1995	8	7	13	30	8.8000e+00	1.8700e+00	6.4750e+01	8.0900e+01	2.2700e-01	3.1250e-01	2.3789e-03	1.3468e-03	-1.0321e-03	-4.3386e-01
20	1995	8	7	14	0	9.8000e+00	2.2000e+00	5.3000e+01	8.1700e+01	2.7000e-02	1.0000e+00	2.5319e-03	1.6754e-03	-8.5656e-04	-3.3830e-01
21	1995	8	7	14	30	8.5000e+00	1.9300e+00	1.0205e+02	8.2000e+01	7.9000e-02	1.0000e+00	2.2867e-03	1.4348e-03	-8.5182e-04	-3.7252e-01
22	1995	8	7	15	0	9.5000e+00	1.3000e+00	8.3120e+01	8.2300e+01	7.2000e-02	7.5000e-01	1.9109e-03	1.4763e-03	-4.3458e-04	-2.2742e-01
23	1995	8	7	15	30	8.7000e+00	1.3400e+00	1.0015e+02	8.2500e+01	4.8000e-02	7.5000e-01	1.7172e-03	1.3475e-03	-3.6968e-04	-2.1528e-01
24	1995	8	7	16	0	9.3000e+00	1.9800e+00	4.8690e+01	8.3300e+01	4.8000e-02	7.5000e-01	1.4587e-03	1.5002e-03	4.1582e-05	2.8507e-02
25	1995	8	7	16	30	8.6000e+00	3.0200e+00	6.3580e+01	8.3300e+01	1.3000e-02	7.5000e-01	1.9686e-03	1.4757e-03	-4.9285e-04	-2.5036e-01
26	1995	8	7	17	0	8.9000e+00	1.2000e+00	8.5320e+01	8.3600e+01	7.6000e-02	7.5000e-01	1.5977e-03	1.3392e-03	-2.5854e-04	-1.6182e-01
27	1995	8	7	17	30	8.5000e+00	2.1300e+00	1.4443e+02	8.4800e+01	2.6500e-01	7.5000e-01	1.5898e-03	1.4053e-03	-1.8452e-04	-1.1607e-01
28	1995	8	7	18	0	8.5000e+00	2.5700e+00	1.5200e+02	8.6100e+01	2.8300e-01	7.5000e-01	2.1459e-03	1.4349e-03	-7.1093e-04	-3.3131e-01
29	1995	8	7	18	30	8.1000e+00	1.5800e+00	1.9935e+02	8.6800e+01	3.0100e-01	7.5000e-01	3.3664e-03	1.2841e-03	-2.0823e-03	-6.1856e-01
30	1995	8	7	19	0	6.4000e+00	2.8400e+00	1.9117e+02	8.6700e+01	7.1000e-02	7.5000e-01	9.3673e-04	1.2177e-03	2.8098e-04	2.9996e-01
31	1995	8	7	19	30	6.8000e+00	2.8000e+00	4.3348e+02	8.6600e+01	1.9600e-01	7.5000e-01	2.5785e-03	1.2892e-03	-1.2893e-03	-5.0002e-01
32	1995	8	8	13	30	6.7000e+00	7.0000e-01	5.2590e+01	7.8600e+01	6.0000e-02	7.5000e-01	9.3976e-04	9.7703e-04	3.7268e-05	3.9657e-02
33	1995	8	8	14	0	6.2000e+00	1.0700e+00	1.3514e+02	7.9400e+01	9.8000e-02	7.5000e-01	1.0187e-03	1.0464e-03	2.7682e-05	2.7174e-02

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
34	1995	8	8	14	30	5.8000e+00	2.8000e-01	1.2487e+02	8.0600e+01	1.0800e-01	7.5000e-01	8.2826e-04	7.3070e-04	-9.7564e-05	-1.1779e-01
35	1995	8	8	15	0	5.5000e+00	1.0800e+00	1.1978e+02	8.1600e+01	2.8200e-01	3.1250e-01	8.0712e-04	8.9215e-04	8.5026e-05	1.0535e-01
36	1995	8	8	15	30	4.8000e+00	1.0400e+00	1.7553e+02	8.2400e+01	9.9000e-02	3.1250e-01	7.9637e-04	8.5777e-04	6.1400e-05	7.7099e-02
37	1995	8	8	16	0	5.0000e+00	2.2000e+00	3.0352e+02	8.3800e+01	2.8400e-01	3.1250e-01	1.1463e-03	1.0364e-03	-1.0987e-04	-9.5850e-02
38	1995	8	8	16	30	6.4000e+00	1.5400e+00	1.8102e+02	8.4900e+01	3.4300e-01	3.1250e-01	8.1057e-04	1.0220e-03	2.1138e-04	2.6078e-01
39	1995	8	8	17	0	6.6000e+00	1.8600e+00	2.7999e+02	8.6000e+01	1.3200e-01	3.1250e-01	1.3838e-03	1.0868e-03	-2.9698e-04	-2.1461e-01
40	1995	8	8	17	30	7.4000e+00	1.2900e+00	2.5307e+02	8.6500e+01	2.0700e-01	3.1250e-01	9.2521e-04	1.0830e-03	1.5776e-04	1.7051e-01
41	1995	8	8	18	0	5.4000e+00	9.8000e-01	8.7993e+02	8.6900e+01	1.5000e-01	3.1250e-01	1.3582e-03	9.3022e-04	-4.2797e-04	-3.1510e-01
42	1995	8	8	18	30	4.5000e+00	1.1100e+00	4.6946e+02	8.7500e+01	2.1500e-01	3.1250e-01	1.3458e-03	8.7051e-04	-4.7532e-04	-3.5318e-01
43	1995	8	8	19	0	5.8000e+00	2.2400e+00	1.7384e+02	8.8000e+01	1.5000e-01	3.1250e-01	1.0339e-03	1.0281e-03	-5.7429e-06	-5.5548e-03
44	1995	8	8	19	30	6.5000e+00	1.6100e+00	1.1731e+02	8.8300e+01	3.0400e-01	3.1250e-01	8.0344e-04	9.9520e-04	1.9176e-04	2.3868e-01
45	1995	8	8	20	0	7.4000e+00	1.1800e+00	3.4983e+02	8.8900e+01	1.2300e-01	0.0000e+00	9.5376e-04	9.4983e-04	-3.9278e-06	-4.1182e-03
46	1995	8	8	20	30	7.5000e+00	2.9100e+00	1.7942e+02	8.9300e+01	1.4500e-01	0.0000e+00	8.9493e-04	1.1125e-03	2.1757e-04	2.4311e-01
47	1995	8	8	21	0	6.5000e+00	1.4800e+00	2.4074e+02	8.9700e+01	7.4000e-02	0.0000e+00	1.1715e-03	8.8525e-04	-2.8629e-04	-2.4437e-01
48	1995	8	8	21	30	6.1000e+00	9.4000e-01	5.0146e+02	8.9700e+01	6.7000e-02	0.0000e+00	7.2629e-04	7.9876e-04	7.2474e-05	9.9786e-02
49	1995	8	8	22	0	4.9000e+00	1.5900e+00	3.6104e+02	8.9800e+01	7.0000e-02	0.0000e+00	6.9983e-04	8.1355e-04	1.1372e-04	1.6249e-01
50	1995	8	8	22	30	5.1000e+00	8.0000e-01	8.6274e+02	8.9500e+01	7.1000e-02	0.0000e+00	6.8941e-04	7.3960e-04	5.0185e-05	7.2794e-02
51	1995	8	8	23	0	4.9000e+00	7.8000e-01	4.7170e+01	8.8600e+01	1.2300e-01	0.0000e+00	2.8633e-04	6.0164e-04	3.1531e-04	1.1012e+00
52	1995	8	8	23	30	4.7000e+00	5.0000e-01	3.7320e+01	8.8100e+01	1.2000e-02	0.0000e+00	2.5071e-04	4.9958e-04	2.4887e-04	9.9264e-01
53	1995	8	9	0	0	3.5000e+00	1.6000e-01	1.8500e+01	8.7500e+01	1.4800e-01	3.1250e-01	1.3223e-04	3.2980e-04	1.9757e-04	1.4942e+00
54	1995	8	9	0	30	3.1000e+00	9.0000e-02	5.2700e+00	8.6300e+01	5.6000e-02	3.1250e-01	1.3640e-05	1.9088e-04	1.7724e-04	1.2994e+01
55	1995	8	9	11	30	3.7000e+00	3.9000e-01	5.0729e+02	7.6800e+01	3.0000e-02	3.1250e-01	1.6968e-04	7.1940e-04	5.4972e-04	3.2397e+00
56	1995	8	9	12	0	3.5000e+00	5.1000e-01	2.1707e+02	7.7400e+01	1.2900e-01	3.1250e-01	2.2011e-04	7.1925e-04	4.9914e-04	2.2677e+00
57	1995	8	9	12	30	4.7000e+00	7.2000e-01	1.2857e+02	7.8700e+01	7.7000e-02	3.1250e-01	2.4038e-04	7.9789e-04	5.5751e-04	2.3193e+00
58	1995	8	9	13	0	3.7000e+00	7.3000e-01	1.1681e+02	7.9800e+01	1.7400e-01	7.5000e-01	2.8979e-04	8.3885e-04	5.4906e-04	1.8947e+00
59	1995	8	9	13	30	3.3000e+00	6.6000e-01	1.2535e+02	8.1300e+01	1.7800e-01	7.5000e-01	3.1769e-04	8.0020e-04	4.8251e-04	1.5188e+00
60	1995	8	9	14	0	3.4000e+00	5.6000e-01	3.0831e+02	8.2700e+01	1.4400e-01	7.5000e-01	4.6920e-04	7.9563e-04	3.2643e-04	6.9572e-01
61	1995	8	9	14	30	2.9000e+00	1.0100e+00	5.2548e+02	8.3900e+01	2.5600e-01	7.5000e-01	4.0795e-04	9.3092e-04	5.2297e-04	1.2819e+00
62	1995	8	9	15	0	2.5000e+00	1.3200e+00	9.5042e+02	8.5300e+01	2.3300e-01	3.1250e-01	5.7479e-04	9.2162e-04	3.4683e-04	6.0340e-01
63	1995	8	9	15	30	2.0000e+00	1.1400e+00	1.6909e+03	8.6400e+01	2.2700e-01	3.1250e-01	7.0937e-04	9.2673e-04	2.1736e-04	3.0642e-01
64	1995	8	9	16	0	2.2000e+00	1.1100e+00	2.6332e+03	8.7100e+01	1.2900e-01	3.1250e-01	6.8463e-04	9.6066e-04	2.7603e-04	4.0318e-01
65	1995	8	9	16	30	2.4000e+00	6.1000e-01	1.2588e+03	8.8200e+01	2.1800e-01	3.1250e-01	8.3391e-04	7.6059e-04	-7.3318e-05	-8.7921e-02
66	1995	8	9	17	0	2.7000e+00	8.2000e-01	1.3258e+03	8.9000e+01	1.7000e-01	7.5000e-01	6.6438e-04	9.1009e-04	2.4571e-04	3.6983e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
67	1995	8	9	17	30	1.8000e+00	8.5000e-01	4.1695e+03	8.9900e+01	5.0300e-01	7.5000e-01	2.0898e-03	1.0223e-03	-1.0675e-03	-5.1080e-01
68	1995	8	9	18	0	3.1000e+00	1.4500e+00	3.0474e+03	9.0900e+01	3.0000e-01	1.0000e+00	1.3496e-03	1.1375e-03	-2.1213e-04	-1.5718e-01
69	1995	8	9	18	30	3.0000e+00	2.3800e+00	1.5747e+03	9.1200e+01	2.0000e-01	1.0000e+00	1.4865e-03	1.1729e-03	-3.1357e-04	-2.1094e-01
70	1995	8	9	19	0	6.0000e+00	5.5900e+00	3.1038e+03	8.8600e+01	3.2630e+00	7.5000e-01	2.4594e-03	1.6225e-03	-8.3683e-04	-3.4026e-01
71	1995	8	9	19	30	5.9000e+00	1.6720e+01	3.1046e+03	8.3200e+01	3.6400e-01	7.5000e-01	2.9019e-03	1.7707e-03	-1.1312e-03	-3.8982e-01
72	1995	8	9	22	0	3.3000e+00	6.7000e-01	1.8573e+02	8.9400e+01	2.4700e-01	1.0000e+00	1.9305e-04	7.9796e-04	6.0491e-04	3.1334e+00
73	1995	8	9	22	30	4.0000e+00	1.1700e+00	1.8106e+03	8.8600e+01	3.0200e-01	1.0000e+00	4.2682e-04	1.0815e-03	6.5465e-04	1.5338e+00
74	1995	8	9	23	0	8.6000e+00	8.8300e+00	9.6396e+02	8.6000e+01	1.4310e+00	1.0000e+00	5.2270e-03	1.8802e-03	-3.3469e-03	-6.4030e-01
75	1995	8	10	0	0	9.6000e+00	2.1400e+00	7.4336e+02	7.6000e+01	4.4100e-01	1.0000e+00	4.2007e-03	1.7995e-03	-2.4012e-03	-5.7163e-01
76	1995	8	10	0	30	5.0000e+00	6.1300e+00	4.4009e+02	7.5800e+01	4.0000e-02	1.0000e+00	9.5517e-04	1.4563e-03	5.0110e-04	5.2461e-01
77	1995	8	10	11	30	1.9000e+00	8.1000e-01	1.6844e+02	7.3900e+01	1.9000e-02	3.1250e-01	2.0171e-04	8.1411e-04	6.1240e-04	3.0360e+00
78	1995	8	10	12	0	2.0000e+00	4.5000e-01	6.5285e+02	7.4900e+01	1.3000e-01	3.1250e-01	3.6110e-04	7.5643e-04	3.9533e-04	1.0948e+00
79	1995	8	10	12	30	2.4000e+00	9.5000e-01	6.4686e+02	7.6500e+01	4.2200e-01	3.1250e-01	1.9579e-04	9.0064e-04	7.0485e-04	3.6000e+00
80	1995	8	10	13	0	3.1000e+00	1.6000e-01	1.2240e+02	7.8500e+01	2.9900e-01	3.1250e-01	2.6995e-04	4.4557e-04	1.7562e-04	6.5058e-01
81	1995	8	10	13	30	3.2000e+00	6.9000e-01	2.8701e+02	8.0100e+01	1.9100e-01	3.1250e-01	2.8774e-04	7.6983e-04	4.8209e-04	1.6754e+00
82	1995	8	10	14	0	3.1000e+00	5.5000e-01	5.1085e+02	8.1300e+01	8.3000e-02	3.1250e-01	2.5622e-04	7.3969e-04	4.8347e-04	1.8869e+00
83	1995	8	10	14	30	3.0000e+00	5.8000e-01	2.8849e+02	8.2600e+01	1.1300e-01	3.1250e-01	1.2927e-03	7.0686e-04	-5.8580e-04	-4.5317e-01
84	1995	8	10	15	0	3.6000e+00	8.4000e-01	3.2209e+02	8.3600e+01	1.4200e-01	7.5000e-01	9.5588e-04	8.7752e-04	-7.8355e-05	-8.1972e-02
85	1995	8	10	15	30	3.5000e+00	1.7200e+00	3.1098e+02	8.4600e+01	1.8400e-01	7.5000e-01	6.6876e-04	1.0118e-03	3.4304e-04	5.1295e-01
86	1995	8	10	16	0	3.1000e+00	1.1200e+00	8.0006e+02	8.6100e+01	4.3700e-01	7.5000e-01	3.1764e-03	9.6651e-04	-2.2099e-03	-6.9572e-01
87	1995	8	10	16	30	4.8000e+00	1.8800e+00	7.2058e+02	8.6800e+01	1.6300e-01	7.5000e-01	1.0125e-03	1.1055e-03	9.3029e-05	9.1879e-02
88	1995	8	10	17	0	4.8000e+00	1.2600e+00	6.3035e+02	8.7500e+01	1.4400e-01	7.5000e-01	9.3155e-04	1.0095e-03	7.7942e-05	8.3669e-02
89	1995	8	10	17	30	4.8000e+00	2.8000e+00	6.3002e+02	8.7900e+01	2.1500e-01	7.5000e-01	1.0142e-03	1.1704e-03	1.5620e-04	1.5402e-01
90	1995	8	10	18	0	4.7000e+00	1.9700e+00	3.8456e+02	8.8700e+01	2.7000e-01	1.0000e+00	1.2393e-03	1.0997e-03	-1.3966e-04	-1.1269e-01
91	1995	8	10	18	30	4.5000e+00	2.4500e+00	5.9001e+02	8.9100e+01	1.8000e-01	1.0000e+00	1.0462e-03	1.1593e-03	1.1317e-04	1.0817e-01
92	1995	8	10	19	0	5.2000e+00	1.7100e+00	3.5863e+02	8.9500e+01	1.8000e-01	1.0000e+00	9.8989e-04	1.0847e-03	9.4824e-05	9.5793e-02
93	1995	8	10	19	30	5.4000e+00	1.8900e+00	4.5728e+02	8.9900e+01	1.4400e-01	1.0000e+00	1.3240e-03	1.1241e-03	-1.9991e-04	-1.5099e-01
94	1995	8	10	20	0	6.5000e+00	1.8600e+00	2.6261e+02	8.9800e+01	1.9400e-01	1.0000e+00	1.1361e-03	1.1704e-03	3.4291e-05	3.0184e-02
95	1995	8	10	20	30	6.0000e+00	8.7000e-01	7.8350e+01	8.9500e+01	1.4500e-01	1.0000e+00	7.9207e-04	9.3258e-04	1.4051e-04	1.7740e-01
96	1995	8	10	21	0	5.4000e+00	1.3600e+00	2.8646e+02	8.9700e+01	1.3100e-01	7.5000e-01	2.3162e-03	9.9665e-04	-1.3196e-03	-5.6971e-01
97	1995	8	10	21	30	4.4000e+00	5.8000e-01	1.2078e+02	8.8800e+01	6.1000e-02	7.5000e-01	2.7516e-04	7.4287e-04	4.6771e-04	1.6998e+00
98	1995	8	10	22	0	4.7000e+00	3.7000e-01	1.1690e+02	8.9400e+01	5.0000e-02	3.1250e-01	3.7516e-04	5.7090e-04	1.9574e-04	5.2175e-01
99	1995	8	10	22	30	4.3000e+00	4.1000e-01	6.7480e+01	8.9000e+01	5.7000e-02	3.1250e-01	3.3664e-04	5.6260e-04	2.2596e-04	6.7123e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
100	1995	8	10	23	0	3.0000e+00	6.3000e-01	1.4444e+02	8.8900e+01	2.8000e-02	3.1250e-01	9.7880e-05	6.4503e-04	5.4715e-04	5.5900e+00
101	1995	8	10	23	30	3.5000e+00	3.1200e+00	7.6334e+03	8.7400e+01	1.6010e+00	3.1250e-01	6.0819e-04	1.3563e-03	7.4810e-04	1.2300e+00
102	1995	8	11	0	0	4.0000e+00	4.7700e+00	9.7322e+02	8.1700e+01	7.3000e-01	3.1250e-01	3.4372e-04	1.2533e-03	9.0956e-04	2.6462e+00
103	1995	8	11	0	30	2.0000e+00	2.5700e+00	6.0454e+03	8.2600e+01	8.5500e-01	3.1250e-01	2.9896e-04	1.2756e-03	9.7662e-04	3.2667e+00
104	1995	8	11	11	30	1.7000e+00	1.6000e-01	3.4960e+01	7.7000e+01	2.7000e-02	3.1250e-01	1.0100e-06	4.0337e-04	4.0236e-04	3.9838e+02
105	1995	8	11	12	0	2.2000e+00	4.6000e-01	2.5469e+02	7.8200e+01	4.0300e-01	7.5000e-01	5.1810e-05	7.7285e-04	7.2104e-04	1.3917e+01
106	1995	8	11	12	30	2.8000e+00	1.8000e-01	7.0830e+01	8.0700e+01	6.6100e-01	7.5000e-01	2.1042e-04	5.1915e-04	3.0873e-04	1.4672e+00
107	1995	8	11	13	0	3.2000e+00	3.1000e-01	2.2861e+02	8.2600e+01	1.3000e-01	7.5000e-01	2.3911e-04	6.5634e-04	4.1723e-04	1.7449e+00
108	1995	8	11	13	30	3.3000e+00	4.1000e-01	1.3411e+02	8.3600e+01	1.6000e-01	7.5000e-01	3.1909e-04	6.8499e-04	3.6590e-04	1.1467e+00
109	1995	8	11	14	0	3.2000e+00	1.0400e+00	2.9312e+02	8.4800e+01	1.4900e-01	7.5000e-01	6.8834e-04	8.9975e-04	2.1141e-04	3.0712e-01
110	1995	8	11	14	30	2.6000e+00	1.4000e+00	9.4459e+02	8.5700e+01	1.1300e-01	7.5000e-01	5.0347e-04	1.0145e-03	5.1105e-04	1.0150e+00
111	1995	8	11	15	0	3.3000e+00	8.9000e-01	4.5037e+02	8.6800e+01	1.1900e-01	7.5000e-01	5.1294e-04	8.7644e-04	3.6350e-04	7.0865e-01
112	1995	8	11	15	30	3.0000e+00	1.8800e+00	3.2478e+02	8.7100e+01	8.9000e-02	7.5000e-01	3.3726e-04	1.0076e-03	6.7038e-04	1.9877e+00
113	1995	8	11	16	0	3.8000e+00	1.7900e+00	6.0212e+02	8.8200e+01	6.9000e-02	3.1250e-01	3.4231e-04	9.5178e-04	6.0947e-04	1.7805e+00
114	1995	8	11	16	30	4.7000e+00	1.6600e+00	2.3104e+02	8.8500e+01	3.9000e-02	3.1250e-01	5.0383e-04	9.1578e-04	4.1195e-04	8.1765e-01
115	1995	8	11	17	0	3.2000e+00	1.2500e+00	1.2573e+03	8.9200e+01	2.3400e-01	3.1250e-01	7.4165e-04	9.1559e-04	1.7394e-04	2.3454e-01
116	1995	8	11	17	30	4.2000e+00	1.3900e+00	4.0483e+02	8.9400e+01	1.9600e-01	3.1250e-01	7.5330e-04	8.8227e-04	1.2897e-04	1.7120e-01
117	1995	8	11	18	0	3.3000e+00	2.0500e+00	1.5263e+03	9.0200e+01	2.3300e-01	3.1250e-01	9.0146e-04	1.0260e-03	1.2458e-04	1.3820e-01
118	1995	8	11	18	30	4.3000e+00	1.4200e+00	1.1792e+03	9.0800e+01	1.5100e-01	3.1250e-01	7.7327e-04	9.5018e-04	1.7691e-04	2.2878e-01
119	1995	8	11	19	0	3.6000e+00	1.2100e+00	2.3532e+03	9.0300e+01	7.1000e-02	3.1250e-01	7.4182e-04	9.5900e-04	2.1718e-04	2.9277e-01
120	1995	8	11	19	30	4.6000e+00	5.9000e-01	6.2793e+02	8.9700e+01	2.7000e-02	3.1250e-01	3.0514e-04	7.4350e-04	4.3836e-04	1.4366e+00
121	1995	8	11	20	0	4.8000e+00	9.7000e-01	7.5074e+02	9.0800e+01	8.8000e-02	7.5000e-01	6.7494e-04	9.4425e-04	2.6931e-04	3.9901e-01
122	1995	8	11	20	30	4.2000e+00	6.5000e-01	4.4658e+02	9.0600e+01	1.0000e-01	7.5000e-01	5.6393e-04	8.0756e-04	2.4363e-04	4.3202e-01
123	1995	8	11	21	0	4.9000e+00	7.7000e-01	1.7885e+02	9.1000e+01	6.3000e-02	3.1250e-01	4.9503e-04	7.3485e-04	2.3982e-04	4.8446e-01
124	1995	8	11	21	30	5.1000e+00	5.0000e-01	4.6894e+02	9.0900e+01	4.1000e-02	3.1250e-01	5.3750e-04	7.0337e-04	1.6587e-04	3.0859e-01
125	1995	8	11	22	0	5.0000e+00	9.2000e-01	1.3380e+02	9.1000e+01	8.0000e-03	0.0000e+00	2.7288e-04	6.5310e-04	3.8022e-04	1.3933e+00
126	1995	8	11	22	30	4.5000e+00	4.7000e-01	1.0113e+02	9.0900e+01	3.3000e-02	0.0000e+00	3.1542e-04	4.8363e-04	1.6821e-04	5.3327e-01
127	1995	8	11	23	0	4.5000e+00	1.0500e+00	6.0540e+01	9.0500e+01	3.9000e-02	0.0000e+00	1.8301e-04	6.3672e-04	4.5371e-04	2.4791e+00
128	1995	8	11	23	30	3.5000e+00	2.7000e-01	5.3250e+01	9.0300e+01	5.8000e-02	0.0000e+00	2.0863e-04	3.2492e-04	1.1629e-04	5.5739e-01
129	1995	8	12	0	0	3.7000e+00	1.7000e-01	8.2840e+01	8.9500e+01	5.4000e-02	0.0000e+00	1.0405e-04	2.5621e-04	1.5216e-04	1.4623e+00
130	1995	8	12	0	30	2.8000e+00	7.0000e-01	1.7886e+02	8.8800e+01	4.1000e-02	0.0000e+00	3.7150e-05	5.6142e-04	5.2427e-04	1.4112e+01
131	1995	8	12	11	30	2.0000e+00	3.8000e-01	1.0740e+02	7.5700e+01	4.4000e-02	3.1250e-01	4.9700e-06	6.2679e-04	6.2182e-04	1.2511e+02
132	1995	8	12	12	0	2.4000e+00	5.0000e-01	5.0149e+02	7.6800e+01	3.7900e-01	3.1250e-01	1.7400e-06	7.5326e-04	7.5152e-04	4.3191e+02

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
133	1995	8	12	12	30	1.1000e+00	3.4000e-01	3.6339e+03	7.8900e+01	9.9300e-01	3.1250e-01	1.6750e-05	8.2843e-04	8.1168e-04	4.8458e+01
134	1995	8	12	13	0	2.2000e+00	1.6000e-01	2.7964e+02	8.1600e+01	4.2800e-01	3.1250e-01	8.1890e-05	4.4440e-04	3.6251e-04	4.4268e+00
135	1995	8	12	13	30	2.5000e+00	3.4000e-01	1.7925e+02	8.3300e+01	2.2800e-01	3.1250e-01	2.0222e-04	5.6634e-04	3.6412e-04	1.8006e+00
136	1995	8	12	14	0	9.0000e-01	2.3000e-01	1.0301e+04	8.5500e+01	7.6100e-01	3.1250e-01	3.7298e-04	8.3439e-04	4.6141e-04	1.2371e+00
137	1995	8	12	14	30	1.4000e+00	4.9000e-01	7.1433e+03	8.7000e+01	1.2600e-01	3.1250e-01	4.7008e-04	9.1049e-04	4.4041e-04	9.3689e-01
138	1995	8	12	15	0	2.1000e+00	6.5000e-01	1.1776e+03	8.7600e+01	1.3700e-01	3.1250e-01	4.2120e-04	7.7314e-04	3.5194e-04	8.3557e-01
139	1995	8	12	15	30	2.0000e+00	1.3200e+00	3.1616e+03	8.8300e+01	1.0000e-01	3.1250e-01	5.7936e-04	1.0010e-03	4.2162e-04	7.2773e-01
140	1995	8	12	16	0	2.3000e+00	2.5900e+00	4.2376e+03	8.8900e+01	1.6000e-01	3.1250e-01	7.1629e-04	1.1733e-03	4.5702e-04	6.3804e-01
141	1995	8	12	16	30	3.4000e+00	1.9300e+00	4.6756e+03	8.9900e+01	1.4100e-01	3.1250e-01	1.5650e-03	1.1317e-03	-4.3332e-04	-2.7689e-01
142	1995	8	12	17	0	2.7000e+00	7.4000e-01	1.1972e+03	8.9900e+01	3.0200e-01	3.1250e-01	1.9397e-04	7.8847e-04	5.9450e-04	3.0649e+00
143	1995	8	12	17	30	3.0000e+00	2.4700e+00	1.4038e+03	9.0500e+01	2.5600e-01	3.1250e-01	6.3664e-04	1.0494e-03	4.1272e-04	6.4828e-01
144	1995	8	12	18	0	3.2000e+00	2.1800e+00	2.3292e+03	9.1200e+01	4.5000e-01	3.1250e-01	1.6904e-03	1.0713e-03	-6.1911e-04	-3.6625e-01
145	1995	8	12	18	30	4.0000e+00	2.4100e+00	5.6114e+02	9.1400e+01	8.7000e-02	3.1250e-01	1.0106e-03	9.9074e-04	-1.9820e-05	-1.9613e-02
146	1995	8	12	19	0	5.3000e+00	1.3700e+00	2.6244e+02	9.1700e+01	2.0400e-01	3.1250e-01	6.5516e-04	8.8673e-04	2.3157e-04	3.5346e-01
147	1995	8	12	19	30	4.0000e+00	4.3900e+00	1.2699e+03	9.1600e+01	9.1000e-02	3.1250e-01	1.0586e-03	1.1707e-03	1.1214e-04	1.0593e-01
148	1995	8	12	20	0	5.0000e+00	2.3700e+00	5.3507e+02	9.1800e+01	1.1600e-01	3.1250e-01	8.3667e-04	1.0211e-03	1.8446e-04	2.2047e-01
149	1995	8	12	20	30	4.6000e+00	2.6200e+00	3.9277e+02	9.2000e+01	5.9000e-02	3.1250e-01	7.2239e-04	1.0037e-03	2.8132e-04	3.8943e-01
150	1995	8	12	21	0	3.7000e+00	3.2200e+00	1.4988e+03	9.1800e+01	5.2000e-02	3.1250e-01	6.3947e-04	1.1125e-03	4.7302e-04	7.3970e-01
151	1995	8	12	21	30	3.2000e+00	1.2500e+00	8.5476e+02	9.1900e+01	2.5000e-02	3.1250e-01	5.8682e-04	8.6480e-04	2.7798e-04	4.7370e-01
152	1995	8	12	22	0	3.4000e+00	9.1000e-01	4.1311e+02	9.1600e+01	1.4000e-02	0.0000e+00	3.0522e-04	6.4567e-04	3.4045e-04	1.1154e+00
153	1995	8	12	22	30	4.1000e+00	6.1000e-01	6.9587e+02	9.1400e+01	5.0000e-02	0.0000e+00	4.7557e-04	6.1303e-04	1.3746e-04	2.8903e-01
154	1995	8	12	23	0	5.6000e+00	6.8000e-01	6.6540e+01	9.1100e+01	3.3000e-02	0.0000e+00	4.4286e-04	5.9991e-04	1.5705e-04	3.5463e-01
155	1995	8	13	16	30	4.9000e+00	2.3400e+00	4.7512e+02	9.0400e+01	3.5400e-01	3.1250e-01	8.7889e-04	1.0182e-03	1.3928e-04	1.5847e-01
156	1995	8	13	17	0	5.1000e+00	8.4000e-01	6.0533e+02	9.0900e+01	2.7400e-01	3.1250e-01	9.3196e-04	8.2778e-04	-1.0418e-04	-1.1179e-01
157	1995	8	13	17	30	4.4000e+00	1.1500e+00	1.4008e+03	9.1200e+01	2.2300e-01	3.1250e-01	8.8376e-04	9.2301e-04	3.9249e-05	4.4411e-02
158	1995	8	13	18	0	3.8000e+00	1.4400e+00	6.8968e+02	9.1900e+01	2.4700e-01	3.1250e-01	9.9622e-04	8.9492e-04	-1.0130e-04	-1.0169e-01
159	1995	8	13	18	30	3.9000e+00	1.5800e+00	3.6481e+02	9.1900e+01	8.0000e-02	3.1250e-01	5.2345e-04	8.7525e-04	3.5180e-04	6.7209e-01
160	1995	8	13	19	0	4.5000e+00	3.2400e+00	4.2129e+02	9.2200e+01	3.7800e-01	3.1250e-01	7.1659e-04	1.0519e-03	3.3535e-04	4.6799e-01
161	1995	8	13	19	30	5.2000e+00	8.2000e-01	6.1497e+02	9.2700e+01	1.0000e-01	3.1250e-01	8.9841e-04	8.1504e-04	-8.3375e-05	-9.2803e-02
162	1995	8	13	20	0	4.0000e+00	1.5000e+00	4.3541e+02	9.2100e+01	1.2100e-01	3.1250e-01	7.1078e-04	8.7437e-04	1.6360e-04	2.3016e-01
163	1995	8	13	20	30	3.9000e+00	2.4700e+00	3.4277e+02	9.2100e+01	2.2300e-01	3.1250e-01	4.9643e-04	9.6268e-04	4.6625e-04	9.3920e-01
164	1995	8	13	21	0	3.5000e+00	9.3000e-01	2.0691e+02	9.2100e+01	1.1300e-01	7.5000e-01	5.1705e-04	8.1226e-04	2.9521e-04	5.7096e-01
165	1995	8	13	21	30	3.7000e+00	1.7300e+00	1.3000e+03	9.2500e+01	7.4000e-02	7.5000e-01	7.5939e-04	1.0510e-03	2.9166e-04	3.8407e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
166	1995	8	13	22	0	3.3000e+00	1.1400e+00	4.5687e+02	9.2200e+01	4.6000e-02	7.5000e-01	4.6293e-04	8.8884e-04	4.2591e-04	9.2004e-01
167	1995	8	13	22	30	3.7000e+00	5.2000e-01	2.4733e+02	9.2000e+01	2.2000e-02	7.5000e-01	6.3760e-04	7.0429e-04	6.6692e-05	1.0460e-01
168	1995	8	13	23	0	3.8000e+00	6.2000e-01	2.6428e+02	9.1700e+01	1.9000e-02	7.5000e-01	2.5212e-04	7.5054e-04	4.9842e-04	1.9769e+00
169	1995	8	13	23	30	3.5000e+00	3.8000e-01	4.3520e+01	9.0900e+01	8.6000e-02	7.5000e-01	1.2720e-04	5.8360e-04	4.5640e-04	3.5881e+00
170	1995	8	14	0	0	2.7000e+00	1.9000e-01	7.3450e+01	9.0100e+01	6.2000e-02	7.5000e-01	2.1490e-05	4.4937e-04	4.2788e-04	1.9911e+01
171	1995	8	14	0	30	3.5000e+00	2.4000e-01	5.2530e+01	8.8600e+01	5.4000e-02	7.5000e-01	1.4200e-06	5.1371e-04	5.1229e-04	3.6077e+02
172	1995	8	14	11	30	2.0000e+00	2.1000e-01	1.1912e+02	7.6100e+01	1.4000e-02	3.1250e-01	4.6200e-05	5.0402e-04	4.5782e-04	9.9094e+00
173	1995	8	14	12	0	2.7000e+00	3.4000e-01	2.4863e+02	7.6900e+01	6.7000e-02	7.5000e-01	1.6256e-04	7.1754e-04	5.5498e-04	3.4140e+00
174	1995	8	14	12	30	3.6000e+00	2.9000e-01	7.4680e+01	7.8200e+01	1.6000e-01	7.5000e-01	3.0052e-04	6.4742e-04	3.4690e-04	1.1543e+00
175	1995	8	14	13	0	3.6000e+00	7.6000e-01	3.9950e+02	7.9700e+01	4.1200e-01	7.5000e-01	2.9401e-04	9.0346e-04	6.0945e-04	2.0729e+00
176	1995	8	14	13	30	4.1000e+00	4.1000e-01	1.0726e+02	8.1100e+01	1.9200e-01	7.5000e-01	4.4797e-04	7.1661e-04	2.6864e-04	5.9967e-01
177	1995	8	14	14	0	5.0000e+00	4.3000e-01	1.3484e+02	8.2200e+01	1.0900e-01	3.1250e-01	4.2798e-04	6.7545e-04	2.4747e-04	5.7823e-01
178	1995	8	14	14	30	5.1000e+00	6.3000e-01	7.9590e+01	8.3300e+01	1.4000e-01	3.1250e-01	3.8251e-04	7.3294e-04	3.5043e-04	9.1613e-01
179	1995	8	14	17	0	4.5000e+00	1.4800e+00	6.8179e+02	8.7100e+01	1.8600e-01	3.1250e-01	1.0583e-03	9.5568e-04	-1.0258e-04	-9.6930e-02
180	1995	8	14	17	30	4.6000e+00	2.7700e+00	2.8271e+02	8.7100e+01	9.1000e-02	3.1250e-01	8.8306e-04	1.0361e-03	1.5306e-04	1.7333e-01
181	1995	8	14	18	0	5.2000e+00	2.7200e+00	1.9072e+02	8.7400e+01	2.4500e-01	3.1250e-01	6.0735e-04	1.0410e-03	4.3370e-04	7.1408e-01
182	1995	8	14	18	30	5.1000e+00	2.7000e+00	2.7498e+02	8.7800e+01	1.5000e-01	3.1250e-01	7.3276e-04	1.0449e-03	3.1213e-04	4.2596e-01
183	1995	8	14	21	0	6.9000e+00	1.5200e+00	2.0231e+02	9.0500e+01	1.0700e-01	0.0000e+00	8.2500e-04	9.1106e-04	8.6063e-05	1.0432e-01
184	1995	8	14	21	30	7.1000e+00	1.4800e+00	3.0691e+02	9.0700e+01	7.4000e-02	0.0000e+00	1.3894e-03	9.4516e-04	-4.4421e-04	-3.1972e-01
185	1995	8	15	0	0	3.9000e+00	5.4000e-01	3.0350e+01	8.8100e+01	7.6000e-02	0.0000e+00	1.2553e-04	4.8361e-04	3.5808e-04	2.8526e+00
186	1995	8	15	0	30	3.3000e+00	7.0000e-02	3.5320e+01	8.6600e+01	4.6000e-02	0.0000e+00	3.3440e-05	6.1120e-05	2.7680e-05	8.2774e-01
187	1995	8	16	11	30	2.3000e+00	4.4000e-01	4.0168e+02	7.7600e+01	1.0100e-01	3.1250e-01	4.2330e-05	7.0114e-04	6.5881e-04	1.5564e+01
188	1995	8	16	12	0	2.7000e+00	6.5000e-01	4.4578e+02	7.8600e+01	5.6900e-01	3.1250e-01	2.6590e-05	7.9165e-04	7.6506e-04	2.8773e+01
189	1995	8	16	12	30	2.4000e+00	5.5000e-01	1.1489e+02	8.1500e+01	6.3900e-01	3.1250e-01	2.2952e-04	6.7078e-04	4.4126e-04	1.9225e+00
190	1995	8	16	14	0	2.3000e+00	8.5000e-01	1.2515e+03	8.6800e+01	3.0100e-01	3.1250e-01	3.9648e-04	8.4074e-04	4.4426e-04	1.1205e+00
191	1995	8	16	14	30	9.0000e-01	2.2000e-01	1.8635e+03	8.7400e+01	1.1000e-02	3.1250e-01	8.1634e-04	5.8421e-04	-2.3213e-04	-2.8436e-01
192	1995	8	16	15	30	3.1000e+00	8.2000e-01	5.7079e+02	8.9900e+01	1.2700e-01	3.1250e-01	9.2084e-04	7.6214e-04	-1.5870e-04	-1.7235e-01
193	1995	8	16	16	0	4.3000e+00	1.2600e+00	4.1074e+02	9.0900e+01	1.9000e-01	3.1250e-01	9.1293e-04	8.5252e-04	-6.0411e-05	-6.6172e-02
194	1995	8	16	16	30	3.3000e+00	1.3300e+00	1.8778e+03	9.1300e+01	9.6000e-02	3.1250e-01	1.1227e-03	9.4694e-04	-1.7579e-04	-1.5657e-01
195	1995	8	16	17	0	3.1000e+00	2.3700e+00	2.9142e+03	9.1800e+01	2.1400e-01	3.1250e-01	7.0725e-04	1.1020e-03	3.9472e-04	5.5810e-01
196	1995	8	16	17	30	3.7000e+00	1.8800e+00	1.2996e+03	9.2700e+01	1.1000e-01	3.1250e-01	1.2046e-03	9.8309e-04	-2.2150e-04	-1.8388e-01
197	1995	8	16	18	0	5.2000e+00	1.4600e+00	1.1399e+03	9.2000e+01	3.8800e-01	3.1250e-01	1.4018e-03	9.8501e-04	-4.1677e-04	-2.9731e-01
198	1995	8	16	18	30	5.1000e+00	2.6900e+00	1.4920e+03	9.2600e+01	2.3400e-01	3.1250e-01	1.1752e-03	1.1203e-03	-5.4861e-05	-4.6684e-02

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
199	1995	8	16	20	0	6.6000e+00	1.7300e+00	2.4130e+02	9.2200e+01	4.2000e-01	0.0000e+00	2.1267e-03	9.1103e-04	-1.2157e-03	-5.7163e-01
200	1995	8	16	20	30	5.8000e+00	9.9000e-01	2.0599e+02	9.3100e+01	3.5900e-01	0.0000e+00	2.0032e-03	7.1883e-04	-1.2843e-03	-6.4115e-01
201	1995	8	16	21	0	4.1000e+00	8.4000e-01	2.2808e+02	9.3400e+01	5.0000e-02	0.0000e+00	1.6254e-03	6.0629e-04	-1.0191e-03	-6.2699e-01
202	1995	8	16	21	30	3.7000e+00	6.4000e-01	7.3504e+02	9.2900e+01	1.9100e-01	0.0000e+00	8.6328e-04	6.0898e-04	-2.5430e-04	-2.9457e-01
203	1995	8	16	22	0	3.3000e+00	5.6000e-01	1.2419e+02	9.2500e+01	2.0000e-02	0.0000e+00	2.1622e-04	4.8241e-04	2.6619e-04	1.2311e+00
204	1995	8	16	22	30	3.2000e+00	1.0300e+00	2.9381e+02	9.2800e+01	4.6000e-02	0.0000e+00	4.2518e-04	6.4093e-04	2.1575e-04	5.0742e-01
205	1995	8	16	23	0	2.8000e+00	1.1000e+00	4.4035e+02	9.2700e+01	1.0300e-01	0.0000e+00	2.2138e-04	6.7115e-04	4.4977e-04	2.0316e+00
206	1995	8	16	23	30	3.0000e+00	1.7000e-01	1.4091e+02	9.2100e+01	1.6000e-02	0.0000e+00	6.3500e-05	2.4112e-04	1.7762e-04	2.7971e+00
207	1995	8	17	0	0	3.0000e+00	1.0000e-01	4.4500e+01	9.1400e+01	6.5000e-02	0.0000e+00	2.1580e-05	9.9961e-05	7.8381e-05	3.6321e+00
208	1995	8	17	0	30	2.4000e+00	6.0000e-02	2.0381e+02	8.9200e+01	7.7800e-01	0.0000e+00	2.3840e-05	7.1283e-05	4.7443e-05	1.9901e+00
209	1995	8	17	11	30	1.2000e+00	2.6000e-01	7.8980e+01	7.9200e+01	1.9000e-02	3.1250e-01	8.3080e-05	5.0362e-04	4.2054e-04	5.0618e+00
210	1995	8	17	12	0	2.9000e+00	2.8000e-01	3.5680e+01	8.0200e+01	2.0700e-01	3.1250e-01	2.5282e-04	5.0260e-04	2.4978e-04	9.8796e-01
211	1995	8	17	12	30	2.4000e+00	3.3000e-01	4.6741e+02	8.2500e+01	6.0700e-01	3.1250e-01	1.9211e-04	6.2107e-04	4.2896e-04	2.2329e+00
212	1995	8	17	13	0	2.4000e+00	2.2000e-01	1.1098e+02	8.4300e+01	1.7100e-01	3.1250e-01	1.7050e-04	4.4909e-04	2.7859e-04	1.6340e+00
213	1995	8	17	13	30	1.3000e+00	4.8000e-01	1.8385e+03	8.5600e+01	4.0700e-01	3.1250e-01	2.2551e-04	7.6071e-04	5.3520e-04	2.3733e+00
214	1995	8	17	14	0	2.2000e+00	2.9000e-01	3.6992e+02	8.7100e+01	2.7400e-01	7.5000e-01	3.7965e-04	6.2326e-04	2.4361e-04	6.4166e-01
215	1995	8	17	14	30	2.6000e+00	8.3000e-01	3.9586e+02	8.8900e+01	1.9000e-01	7.5000e-01	5.7956e-04	8.3045e-04	2.5089e-04	4.3289e-01
216	1995	8	17	16	0	2.7000e+00	2.4000e+00	2.8312e+03	9.1800e+01	1.4600e-01	7.5000e-01	9.2047e-04	1.1801e-03	2.5967e-04	2.8211e-01
217	1995	8	17	16	30	2.6000e+00	1.2900e+00	2.6996e+03	9.2600e+01	3.9200e-01	7.5000e-01	1.1605e-03	1.0425e-03	-1.1796e-04	-1.0165e-01
218	1995	8	17	17	0	3.4000e+00	1.6400e+00	9.3705e+02	9.3700e+01	3.3300e-01	7.5000e-01	1.2030e-03	1.0024e-03	-2.0062e-04	-1.6677e-01
219	1995	8	17	17	30	4.7000e+00	2.1600e+00	9.4784e+02	9.4000e+01	3.1800e-01	7.5000e-01	1.5313e-03	1.1010e-03	-4.3034e-04	-2.8102e-01
220	1995	8	17	18	0	4.5000e+00	2.7800e+00	8.1323e+02	9.4300e+01	2.1100e-01	7.5000e-01	1.3712e-03	1.1281e-03	-2.4314e-04	-1.7731e-01
221	1995	8	17	18	30	4.2000e+00	2.7600e+00	8.3729e+02	9.4900e+01	5.5800e-01	7.5000e-01	1.2771e-03	1.1194e-03	-1.5771e-04	-1.2349e-01
222	1995	8	17	20	0	4.1000e+00	4.7000e-01	2.4133e+02	9.3700e+01	5.3500e-01	0.0000e+00	3.4073e-04	4.9233e-04	1.5160e-04	4.4492e-01
223	1995	8	17	20	30	3.9000e+00	1.1100e+00	3.0531e+02	9.4900e+01	1.6600e-01	0.0000e+00	7.3033e-04	6.6112e-04	-6.9214e-05	-9.4771e-02
224	1995	8	18	0	0	2.3000e+00	4.6000e-01	5.9160e+01	8.6100e+01	1.9000e-02	0.0000e+00	9.0090e-05	4.5162e-04	3.6153e-04	4.0129e+00
225	1995	8	18	0	30	2.1000e+00	1.3000e-01	2.5072e+02	8.5700e+01	3.2200e-01	0.0000e+00	2.5100e-06	2.5104e-04	2.4853e-04	9.9014e+01
226	1995	8	18	14	0	3.1000e+00	5.9000e-01	2.4307e+02	8.8800e+01	4.3100e-01	3.1250e-01	5.5563e-04	6.6047e-04	1.0484e-04	1.8868e-01
227	1995	8	18	14	30	2.8000e+00	1.2200e+00	1.0741e+03	9.0000e+01	1.6200e-01	3.1250e-01	6.9169e-04	8.8340e-04	1.9171e-04	2.7717e-01
228	1995	8	18	15	0	2.8000e+00	1.3200e+00	7.2855e+02	9.0900e+01	1.8900e-01	3.1250e-01	1.0582e-03	8.6286e-04	-1.9536e-04	-1.8462e-01
229	1995	8	18	15	30	2.6000e+00	6.8000e-01	1.6285e+03	9.1700e+01	4.7200e-01	3.1250e-01	7.9855e-04	7.8710e-04	-1.1447e-05	-1.4335e-02
230	1995	8	18	16	0	2.6000e+00	2.2500e+00	3.3550e+03	9.2800e+01	3.2000e-01	3.1250e-01	1.7019e-03	1.0944e-03	-6.0745e-04	-3.5693e-01
231	1995	8	18	16	30	3.7000e+00	3.0000e+00	9.3151e+02	9.3400e+01	2.8400e-01	3.1250e-01	1.8093e-03	1.0512e-03	-7.5808e-04	-4.1899e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
232	1995	8	18	17	0	4.4000e+00	3.0400e+00	4.7859e+02	9.3700e+01	1.6100e-01	0.0000e+00	7.9393e-04	9.1444e-04	1.2051e-04	1.5178e-01
233	1995	8	18	17	30	3.8000e+00	2.6300e+00	1.1429e+03	9.3900e+01	3.4700e-01	0.0000e+00	1.3093e-03	9.2794e-04	-3.8137e-04	-2.9128e-01
234	1995	8	18	23	0	4.0000e+00	5.1000e-01	1.2015e+02	9.3900e+01	3.8200e-01	3.1250e-01	3.7552e-04	5.8637e-04	2.1085e-04	5.6149e-01
235	1995	8	18	23	30	3.6000e+00	6.0000e-01	1.5545e+02	9.3200e+01	3.4000e-02	3.1250e-01	2.5807e-04	6.1824e-04	3.6017e-04	1.3956e+00
236	1995	8	19	0	0	3.5000e+00	3.4000e-01	2.1160e+01	9.2100e+01	2.4900e-01	3.1250e-01	2.3504e-04	4.5264e-04	2.1760e-04	9.2581e-01
237	1995	8	19	0	30	3.4000e+00	1.7000e-01	5.4560e+01	9.0600e+01	1.7300e-01	3.1250e-01	3.0565e-04	3.4175e-04	3.6099e-05	1.1810e-01
238	1995	8	19	15	0	3.4000e+00	1.4800e+00	6.2209e+02	9.1800e+01	1.9400e-01	1.0000e+00	7.3394e-04	1.0090e-03	2.7510e-04	3.7483e-01
239	1995	8	19	15	30	3.5000e+00	1.5400e+00	1.0035e+03	9.2500e+01	2.8200e-01	1.0000e+00	8.6983e-04	1.0448e-03	1.7493e-04	2.0110e-01
240	1995	8	19	21	0	1.8600e+01	3.9770e+01	2.8052e+02	8.0000e+01	3.2726e+01	3.1250e-01	1.3516e-02	1.0159e-02	-3.3564e-03	-2.4833e-01
241	1995	8	19	21	30	8.0000e+00	3.8900e+00	7.4450e+01	8.2300e+01	1.0410e+01	3.1250e-01	7.5935e-04	2.0140e-03	1.2546e-03	1.6523e+00
242	1995	8	20	14	0	4.7000e+00	2.2800e+00	6.5950e+01	8.3500e+01	1.0500e-01	3.1250e-01	3.8268e-04	9.7299e-04	5.9031e-04	1.5426e+00
243	1995	8	20	14	30	4.8000e+00	7.9000e-01	1.8391e+02	8.4100e+01	1.0500e-01	3.1250e-01	4.5627e-04	7.8778e-04	3.3151e-04	7.2657e-01
244	1995	8	20	15	0	3.6000e+00	6.5000e-01	2.1720e+02	8.5000e+01	2.6600e-01	3.1250e-01	5.9669e-04	7.1463e-04	1.1794e-04	1.9765e-01
245	1995	8	20	15	30	2.9000e+00	9.5000e-01	1.8171e+03	8.6800e+01	3.6000e-02	3.1250e-01	8.9105e-04	8.9844e-04	7.3934e-06	8.2974e-03
246	1995	8	20	17	0	4.4000e+00	2.9200e+00	4.6098e+02	8.9900e+01	1.1800e-01	3.1250e-01	1.2834e-03	1.0433e-03	-2.4011e-04	-1.8709e-01
247	1995	8	20	17	30	5.3000e+00	1.7400e+00	5.7577e+02	9.0500e+01	2.3200e-01	3.1250e-01	1.3495e-03	9.8642e-04	-3.6312e-04	-2.6907e-01
248	1995	8	20	18	0	4.8000e+00	2.6400e+00	3.4071e+02	9.1300e+01	2.1800e-01	3.1250e-01	1.3822e-03	1.0140e-03	-3.6822e-04	-2.6639e-01
249	1995	8	20	18	30	6.0000e+00	2.6500e+00	5.0190e+02	9.2000e+01	2.5500e-01	3.1250e-01	1.7866e-03	1.0984e-03	-6.8815e-04	-3.8517e-01
250	1995	8	20	23	0	8.0000e+00	6.6400e+00	2.2083e+02	9.1000e+01	8.5000e-02	0.0000e+00	1.8222e-03	1.3403e-03	-4.8185e-04	-2.6444e-01
251	1995	8	20	23	30	9.1000e+00	4.8700e+00	9.5090e+01	9.0100e+01	9.5000e-02	0.0000e+00	1.7526e-03	1.4225e-03	-3.3005e-04	-1.8832e-01
252	1995	8	21	15	0	6.2000e+00	9.6000e-01	1.2989e+02	8.5000e+01	1.6000e-01	3.1250e-01	1.0507e-03	8.9377e-04	-1.5689e-04	-1.4933e-01
253	1995	8	21	15	30	7.0000e+00	1.9900e+00	1.3010e+02	8.6400e+01	2.0900e-01	3.1250e-01	1.0511e-03	1.1034e-03	5.2283e-05	4.9742e-02
254	1995	8	21	16	0	7.5000e+00	1.5700e+00	1.2687e+02	8.8000e+01	5.6000e-01	3.1250e-01	1.8765e-03	1.1018e-03	-7.7468e-04	-4.1284e-01
255	1995	8	21	16	30	9.1000e+00	2.0900e+00	1.5083e+02	8.8200e+01	5.4600e-01	3.1250e-01	1.2577e-03	1.3958e-03	1.3812e-04	1.0982e-01
256	1995	8	21	23	0	9.8000e+00	1.4100e+00	1.4950e+01	8.7200e+01	4.1000e-02	0.0000e+00	1.0546e-03	1.2764e-03	2.2181e-04	2.1034e-01
257	1995	8	21	23	30	7.8000e+00	1.4400e+00	2.6150e+01	8.7300e+01	1.0000e-02	0.0000e+00	9.1879e-04	9.6046e-04	4.1674e-05	4.5358e-02
258	1995	8	22	11	30	5.7000e+00	6.7000e-01	2.4840e+01	7.8800e+01	1.3000e-02	3.1250e-01	6.6010e-04	7.8428e-04	1.2418e-04	1.8813e-01
259	1995	8	22	14	0	7.1000e+00	1.2600e+00	7.8820e+01	8.4000e+01	3.0300e-01	3.1250e-01	2.1519e-03	1.0219e-03	-1.1300e-03	-5.2512e-01
260	1995	8	22	14	30	7.1000e+00	7.6000e-01	4.9570e+01	8.5200e+01	6.5000e-02	3.1250e-01	1.3684e-03	8.9096e-04	-4.7745e-04	-3.4891e-01
261	1995	8	22	17	0	7.1000e+00	1.4700e+00	1.9116e+02	9.0900e+01	3.4000e-01	3.1250e-01	1.5472e-03	1.0318e-03	-5.1537e-04	-3.3310e-01
262	1995	8	22	17	30	6.8000e+00	2.8900e+00	9.0410e+01	9.0800e+01	5.9900e-01	3.1250e-01	1.0254e-03	1.1229e-03	9.7475e-05	9.5056e-02
263	1995	8	22	18	0	7.9000e+00	2.6300e+00	2.5111e+02	9.1800e+01	2.8300e-01	3.1250e-01	1.7406e-03	1.2519e-03	-4.8867e-04	-2.8075e-01
264	1995	8	22	18	30	7.8000e+00	2.7400e+00	1.8665e+02	9.2100e+01	4.0000e-01	3.1250e-01	1.5233e-03	1.2338e-03	-2.8945e-04	-1.9001e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
265	1995	8	22	20	30	8.8000e+00	4.7700e+00	3.9605e+02	9.2100e+01	2.2300e-01	0.0000e+00	1.3120e-03	1.4135e-03	1.0148e-04	7.7348e-02
266	1995	8	22	21	0	1.0000e+01	4.6200e+00	1.9024e+02	9.2600e+01	1.0200e-01	0.0000e+00	1.9536e-03	1.5947e-03	-3.5885e-04	-1.8369e-01
267	1995	8	22	21	30	9.5000e+00	2.7000e+00	1.0774e+02	9.2600e+01	1.2100e-01	0.0000e+00	1.6031e-03	1.3596e-03	-2.4354e-04	-1.5192e-01
268	1995	8	22	23	0	1.1400e+01	1.3200e+00	2.4170e+01	9.0100e+01	1.2000e-01	3.1250e-01	1.1377e-03	1.7617e-03	6.2396e-04	5.4842e-01
269	1995	8	22	23	30	1.1100e+01	1.7000e+00	1.5260e+01	8.8900e+01	1.4200e-01	3.1250e-01	1.6144e-03	1.7298e-03	1.1532e-04	7.1433e-02
270	1995	8	23	13	0	5.6000e+00	1.3900e+00	8.1120e+01	7.5000e+01	3.0400e-01	0.0000e+00	9.9540e-04	8.8656e-04	-1.0884e-04	-1.0935e-01
271	1995	8	23	13	30	6.0000e+00	1.4000e+00	1.0881e+02	7.6600e+01	3.8200e-01	0.0000e+00	1.0940e-03	9.0834e-04	-1.8561e-04	-1.6967e-01
272	1995	8	23	14	0	7.2000e+00	1.6300e+00	1.4333e+02	7.8100e+01	1.3000e-01	0.0000e+00	1.3183e-03	1.0403e-03	-2.7795e-04	-2.1084e-01
273	1995	8	23	14	30	6.9000e+00	1.4400e+00	9.9630e+01	7.9300e+01	2.8400e-01	0.0000e+00	9.6161e-04	9.6257e-04	9.5938e-07	9.9768e-04
274	1995	8	23	15	0	6.4000e+00	8.9000e-01	1.2716e+02	8.1200e+01	5.0400e-01	0.0000e+00	1.0938e-03	8.1461e-04	-2.7921e-04	-2.5526e-01
275	1995	8	23	15	30	7.9000e+00	1.5100e+00	7.1500e+01	8.2900e+01	2.1400e-01	0.0000e+00	1.4930e-03	1.0461e-03	-4.4692e-04	-2.9934e-01
276	1995	8	23	17	0	8.1000e+00	2.4400e+00	1.0411e+02	8.6100e+01	1.8600e-01	0.0000e+00	1.5069e-03	1.1551e-03	-3.5181e-04	-2.3347e-01
277	1995	8	23	17	30	7.9000e+00	4.0700e+00	1.9842e+02	8.6900e+01	3.4800e-01	0.0000e+00	1.6130e-03	1.2569e-03	-3.5604e-04	-2.2073e-01
278	1995	8	23	18	0	7.7000e+00	3.0700e+00	2.0161e+02	8.7500e+01	2.1500e-01	0.0000e+00	1.9155e-03	1.1676e-03	-7.4786e-04	-3.9042e-01
279	1995	8	23	18	30	6.9000e+00	3.2400e+00	3.9443e+02	8.7800e+01	2.6000e-01	0.0000e+00	2.3700e-03	1.1216e-03	-1.2484e-03	-5.2676e-01
280	1995	8	23	20	0	6.8000e+00	3.9800e+00	4.4638e+02	8.8500e+01	2.3600e-01	0.0000e+00	1.7364e-03	1.1563e-03	-5.8017e-04	-3.3411e-01
281	1995	8	23	20	30	5.9000e+00	3.2300e+00	3.3511e+02	8.8600e+01	2.6200e-01	0.0000e+00	1.3997e-03	1.0246e-03	-3.7513e-04	-2.6800e-01
282	1995	8	23	21	0	7.1000e+00	3.9800e+00	2.9709e+02	8.8600e+01	8.3000e-02	0.0000e+00	1.4482e-03	1.1625e-03	-2.8574e-04	-1.9731e-01
283	1995	8	23	21	30	7.8000e+00	1.7500e+00	1.2885e+02	8.8400e+01	2.2600e-01	0.0000e+00	1.7516e-03	1.0395e-03	-7.1218e-04	-4.0658e-01
284	1995	8	23	22	0	8.0000e+00	2.3200e+00	2.0205e+02	8.8200e+01	5.7000e-02	0.0000e+00	1.1586e-03	1.1404e-03	-1.8164e-05	-1.5677e-02
285	1995	8	23	22	30	8.0000e+00	1.2600e+00	1.3407e+02	8.7700e+01	1.3400e-01	0.0000e+00	7.8382e-04	1.0012e-03	2.1740e-04	2.7736e-01
286	1995	8	24	0	0	6.9000e+00	8.4000e-01	1.5740e+01	8.4600e+01	1.6300e-01	0.0000e+00	3.4524e-04	7.5988e-04	4.1464e-04	1.2010e+00
287	1995	8	24	11	30	3.2000e+00	2.2000e-01	2.1730e+01	7.2000e+01	1.5000e-02	0.0000e+00	4.1920e-04	4.0495e-04	-1.4254e-05	-3.4004e-02
288	1995	8	24	14	0	4.1000e+00	4.3000e-01	1.9214e+02	7.8700e+01	2.1500e-01	3.1250e-01	1.2679e-03	6.8729e-04	-5.8056e-04	-4.5791e-01
289	1995	8	24	14	30	4.2000e+00	8.8000e-01	5.1539e+02	8.0000e+01	1.5500e-01	3.1250e-01	8.7705e-04	8.7580e-04	-1.2506e-06	-1.4259e-03
290	1995	8	24	15	0	3.2000e+00	8.2000e-01	2.6492e+02	8.1600e+01	3.3500e-01	3.1250e-01	9.7934e-04	7.8791e-04	-1.9143e-04	-1.9546e-01
291	1995	8	24	15	30	3.3000e+00	1.1200e+00	6.0324e+02	8.2700e+01	1.9200e-01	3.1250e-01	6.7704e-04	8.8963e-04	2.1259e-04	3.1400e-01
292	1995	8	24	18	0	3.4000e+00	2.3000e+00	2.3964e+03	9.0100e+01	2.0200e-01	0.0000e+00	1.4779e-03	9.8258e-04	-4.9529e-04	-3.3514e-01
293	1995	8	24	18	30	3.7000e+00	2.0800e+00	1.0490e+03	8.9800e+01	4.6500e-01	0.0000e+00	9.4414e-04	8.9950e-04	-4.4640e-05	-4.7281e-02
294	1995	8	24	21	0	6.3000e+00	8.3000e-01	1.6528e+02	9.0300e+01	7.0000e-02	0.0000e+00	7.4767e-04	7.2612e-04	-2.1553e-05	-2.8827e-02
295	1995	8	24	21	30	5.7000e+00	7.8000e-01	1.5485e+02	9.0100e+01	5.4000e-02	0.0000e+00	9.7410e-04	6.7121e-04	-3.0289e-04	-3.1094e-01
296	1995	8	24	23	0	6.1000e+00	5.7000e-01	2.4890e+01	8.8800e+01	2.5000e-02	0.0000e+00	1.2695e-03	5.8892e-04	-6.8060e-04	-5.3611e-01
297	1995	8	24	23	30	5.7000e+00	8.1000e-01	2.2590e+01	8.8400e+01	5.6000e-02	0.0000e+00	1.5025e-03	6.3582e-04	-8.6668e-04	-5.7683e-01

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DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
298	1995	8	25	0	0	5.2000e+00	6.6000e-01	2.8880e+01	8.7700e+01	1.1700e-01	0.0000e+00	6.0111e-04	5.7392e-04	-2.7191e-05	-4.5234e-02
299	1995	8	25	13	0	3.9000e+00	5.7000e-01	8.9250e+01	7.9200e+01	2.2900e-01	7.5000e-01	1.0899e-03	7.8929e-04	-3.0066e-04	-2.7585e-01
300	1995	8	25	13	30	4.9000e+00	6.0000e-01	1.2366e+02	8.0600e+01	1.5400e-01	7.5000e-01	8.6288e-04	8.3766e-04	-2.5222e-05	-2.9230e-02
301	1995	8	25	14	0	3.5000e+00	6.5000e-01	7.2334e+02	8.1500e+01	1.4700e-01	7.5000e-01	7.3524e-04	8.8946e-04	1.5422e-04	2.0975e-01
302	1995	8	25	14	30	2.7000e+00	6.5000e-01	6.1837e+02	8.2600e+01	3.1000e-01	7.5000e-01	4.2971e-04	8.5637e-04	4.2666e-04	9.9291e-01
303	1995	8	25	15	0	1.9000e+00	1.2300e+00	3.3956e+03	8.4000e+01	2.5100e-01	7.5000e-01	5.6399e-04	1.1161e-03	5.5213e-04	9.7898e-01
304	1995	8	25	15	30	2.4000e+00	1.0500e+00	1.4861e+03	8.6000e+01	2.2400e-01	7.5000e-01	9.1475e-04	9.9076e-04	7.6010e-05	8.3094e-02
305	1995	8	25	16	0	3.0000e+00	1.1200e+00	3.1299e+03	8.7900e+01	3.7800e-01	3.1250e-01	1.3527e-03	9.8637e-04	-3.6632e-04	-2.7081e-01
306	1995	8	25	16	30	3.6000e+00	2.5600e+00	4.9332e+02	8.9400e+01	2.1700e-01	3.1250e-01	1.1647e-03	1.0020e-03	-1.6269e-04	-1.3969e-01
307	1995	8	25	17	0	4.5000e+00	1.8100e+00	5.6039e+02	9.0500e+01	2.7800e-01	3.1250e-01	1.4192e-03	9.5874e-04	-4.6044e-04	-3.2444e-01
308	1995	8	25	17	30	4.9000e+00	2.2600e+00	3.4214e+02	9.1200e+01	3.9800e-01	3.1250e-01	1.5515e-03	9.8974e-04	-5.6177e-04	-3.6208e-01
309	1995	8	25	18	0	5.9000e+00	2.7400e+00	8.2904e+02	9.1300e+01	5.0300e-01	3.1250e-01	1.8185e-03	1.1433e-03	-6.7527e-04	-3.7133e-01
310	1995	8	25	18	30	6.0000e+00	3.6500e+00	4.6233e+02	9.0700e+01	2.6100e-01	3.1250e-01	1.4985e-03	1.1716e-03	-3.2688e-04	-2.1814e-01
311	1995	8	25	20	0	7.7000e+00	9.3000e-01	1.5163e+02	9.1200e+01	2.5800e-01	0.0000e+00	9.4200e-04	8.8433e-04	-5.7672e-05	-6.1223e-02
312	1995	8	25	20	30	6.4000e+00	1.8500e+00	2.4809e+02	9.0400e+01	7.4000e-02	0.0000e+00	1.4194e-03	9.1697e-04	-5.0246e-04	-3.5399e-01
313	1995	8	25	21	0	6.0000e+00	1.8500e+00	2.8438e+02	9.0900e+01	4.3100e-01	3.1250e-01	1.8654e-03	1.0054e-03	-8.6003e-04	-4.6103e-01
314	1995	8	25	21	30	6.0000e+00	3.6600e+00	3.5816e+02	9.1600e+01	4.4000e-01	3.1250e-01	2.0655e-03	1.1528e-03	-9.1263e-04	-4.4185e-01
315	1995	8	26	0	0	5.3000e+00	1.4100e+00	3.9390e+01	8.8400e+01	1.4800e-01	0.0000e+00	7.3691e-04	7.3956e-04	2.6493e-06	3.5951e-03
316	1995	8	26	12	0	2.6000e+00	4.5000e-01	1.7433e+02	7.8300e+01	5.2000e-02	0.0000e+00	8.5240e-05	5.4976e-04	4.6452e-04	5.4495e+00
317	1995	8	26	12	30	3.9000e+00	6.1000e-01	1.3582e+02	7.9100e+01	1.7400e-01	0.0000e+00	2.5323e-04	6.2396e-04	3.7073e-04	1.4640e+00
318	1995	8	26	14	0	4.4000e+00	9.5000e-01	1.4331e+02	8.2800e+01	2.8200e-01	3.1250e-01	5.7009e-04	8.1387e-04	2.4378e-04	4.2761e-01
319	1995	8	26	14	30	3.8000e+00	7.2000e-01	2.1296e+02	8.4300e+01	5.9300e-01	3.1250e-01	6.1502e-04	7.4954e-04	1.3452e-04	2.1872e-01
320	1995	8	26	15	0	4.0000e+00	6.9000e-01	2.3151e+02	8.5700e+01	1.9200e-01	0.0000e+00	6.8001e-04	6.1989e-04	-6.0122e-05	-8.8413e-02
321	1995	8	26	15	30	4.7000e+00	9.0000e-01	3.0342e+02	8.7200e+01	3.8200e-01	0.0000e+00	1.0993e-03	7.0228e-04	-3.9697e-04	-3.6113e-01
322	1995	8	26	16	0	5.0000e+00	1.2700e+00	1.5786e+02	8.9400e+01	7.4300e-01	0.0000e+00	1.4381e-03	7.4965e-04	-6.8849e-04	-4.7874e-01
323	1995	8	26	16	30	6.6000e+00	2.6100e+00	1.1827e+02	9.1100e+01	2.7900e-01	0.0000e+00	1.5810e-03	9.7064e-04	-6.1037e-04	-3.8606e-01
324	1995	8	26	17	0	9.7000e+00	1.5800e+00	8.0660e+01	9.1700e+01	1.8900e-01	0.0000e+00	1.9027e-03	1.2884e-03	-6.1438e-04	-3.2289e-01
325	1995	8	26	17	30	9.6000e+00	2.5100e+00	9.3940e+01	9.2600e+01	1.8300e-01	0.0000e+00	2.3431e-03	1.3606e-03	-9.8245e-04	-4.1930e-01
326	1995	8	26	21	0	9.4000e+00	2.6400e+00	7.3370e+01	9.2500e+01	9.8000e-02	0.0000e+00	1.4223e-03	1.3226e-03	-9.9754e-05	-7.0133e-02
327	1995	8	26	21	30	8.8000e+00	3.4100e+00	1.3584e+02	9.2600e+01	7.9000e-02	0.0000e+00	1.4715e-03	1.2907e-03	-1.8083e-04	-1.2289e-01
328	1995	8	27	20	0	7.3000e+00	6.3300e+00	4.5825e+02	9.0300e+01	1.3500e-01	7.5000e-01	1.8766e-03	1.4837e-03	-3.9288e-04	-2.0936e-01
329	1995	8	27	20	30	5.9000e+00	2.7400e+00	3.4644e+02	9.0800e+01	5.2400e-01	7.5000e-01	1.8589e-03	1.1803e-03	-6.7864e-04	-3.6507e-01
330	1995	8	27	21	0	6.7000e+00	2.8500e+00	2.6093e+02	9.1400e+01	1.5500e-01	3.1250e-01	1.8475e-03	1.1376e-03	-7.0991e-04	-3.8425e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
331	1995	8	27	21	30	8.2000e+00	6.2800e+00	2.4742e+02	9.1200e+01	1.0100e-01	3.1250e-01	1.5267e-03	1.4722e-03	-5.4406e-05	-3.5637e-02
332	1995	8	27	22	0	7.6000e+00	3.9700e+00	2.7059e+02	9.0700e+01	2.3100e-01	3.1250e-01	1.3698e-03	1.3108e-03	-5.9014e-05	-4.3082e-02
333	1995	8	27	22	30	9.1000e+00	3.1600e+00	1.7079e+02	8.9400e+01	9.7000e-02	3.1250e-01	8.2617e-04	1.4714e-03	6.4523e-04	7.8099e-01
334	1995	8	28	0	0	6.2000e+00	2.0300e+00	1.9180e+01	8.7900e+01	6.1000e-02	0.0000e+00	2.8927e-04	8.5863e-04	5.6936e-04	1.9683e+00
335	1995	8	28	16	0	4.6000e+00	1.0700e+00	3.4300e+02	8.8500e+01	4.5200e-01	3.1250e-01	1.3615e-03	8.4599e-04	-5.1554e-04	-3.7865e-01
336	1995	8	28	16	30	5.3000e+00	2.0900e+00	5.2694e+02	8.9800e+01	2.8400e-01	3.1250e-01	1.8882e-03	1.0249e-03	-8.6333e-04	-4.5722e-01
337	1995	8	28	17	0	6.1000e+00	2.3700e+00	5.3958e+02	9.0500e+01	2.9900e-01	3.1250e-01	2.0368e-03	1.0979e-03	-9.3888e-04	-4.6095e-01
338	1995	8	28	17	30	6.8000e+00	3.7400e+00	3.3435e+02	9.1300e+01	6.0200e-01	3.1250e-01	2.7777e-03	1.2270e-03	-1.5507e-03	-5.5826e-01
339	1995	8	28	18	0	7.4000e+00	5.8900e+00	1.4025e+02	9.1300e+01	3.4900e-01	0.0000e+00	1.4112e-03	1.2268e-03	-1.8435e-04	-1.3064e-01
340	1995	8	28	18	30	7.8000e+00	4.0300e+00	1.8478e+02	9.2300e+01	3.2200e-01	0.0000e+00	1.9756e-03	1.1990e-03	-7.7663e-04	-3.9310e-01
341	1995	8	28	19	0	8.0000e+00	6.2100e+00	4.1729e+02	9.2600e+01	6.2200e-01	0.0000e+00	2.3970e-03	1.3545e-03	-1.0425e-03	-4.3494e-01
342	1995	8	28	19	30	8.4000e+00	5.8200e+00	1.2184e+02	9.2900e+01	3.0000e-01	0.0000e+00	1.4493e-03	1.3368e-03	-1.1249e-04	-7.7614e-02
343	1995	8	28	20	0	7.8000e+00	3.5700e+00	1.3253e+02	9.3600e+01	5.3100e-01	0.0000e+00	2.7524e-03	1.1535e-03	-1.5988e-03	-5.8089e-01
344	1995	8	28	20	30	8.2000e+00	5.9200e+00	2.1967e+02	9.3100e+01	2.3200e-01	0.0000e+00	1.2113e-03	1.3291e-03	1.1781e-04	9.7266e-02
345	1995	8	29	14	0	6.5000e+00	1.1800e+00	6.1080e+01	8.4300e+01	5.7000e-01	3.1250e-01	1.4588e-03	9.4698e-04	-5.1178e-04	-3.5083e-01
346	1995	8	29	14	30	5.6000e+00	7.2000e-01	8.9440e+01	8.6300e+01	4.0200e-01	3.1250e-01	1.2857e-03	7.7282e-04	-5.1293e-04	-3.9894e-01
347	1995	8	29	16	0	5.0000e+00	2.0600e+00	3.4327e+02	9.0100e+01	1.6600e-01	3.1250e-01	1.0549e-03	9.8173e-04	-7.3196e-05	-6.9384e-02
348	1995	8	29	16	30	4.1000e+00	2.3500e+00	5.5475e+02	9.1100e+01	4.3000e-01	3.1250e-01	1.3227e-03	9.9699e-04	-3.2571e-04	-2.4624e-01
349	1995	8	29	17	0	4.7000e+00	3.4400e+00	9.9981e+02	9.1800e+01	2.6100e-01	3.1250e-01	1.1107e-03	1.1298e-03	1.9118e-05	1.7212e-02
350	1995	8	29	17	30	3.2000e+00	2.3000e+00	2.5499e+03	9.2800e+01	6.9600e-01	3.1250e-01	2.1482e-03	1.0863e-03	-1.0620e-03	-4.9435e-01
351	1995	8	29	18	0	3.7000e+00	2.7700e+00	1.3981e+03	9.2800e+01	4.2500e-01	3.1250e-01	1.3794e-03	1.0721e-03	-3.0733e-04	-2.2280e-01
352	1995	8	29	18	30	3.1000e+00	2.0900e+00	2.2341e+03	9.2700e+01	1.7100e-01	3.1250e-01	1.7954e-03	1.0419e-03	-7.5348e-04	-4.1967e-01
353	1995	8	29	20	0	4.7000e+00	1.5900e+00	5.5616e+02	9.4400e+01	1.8700e-01	0.0000e+00	1.4470e-03	7.9918e-04	-6.4781e-04	-4.4770e-01
354	1995	8	29	20	30	3.7000e+00	1.8600e+00	2.2849e+03	9.4500e+01	4.3800e-01	0.0000e+00	1.1261e-03	9.1297e-04	-2.1308e-04	-1.8922e-01

concluded

Appendix C

Data point definitions and model EDR predictions for the MEM night data subset

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
1	1995	8	6	0	0	2.0000e+00	2.0000e-01	1.1807e+02	8.4200e+01	2.0000e-02	3.1250e-01	9.8920e-05	6.0315e-05	-3.8605e-05	-3.9026e-01
2	1995	8	6	0	30	1.0000e+00	1.5000e-01	2.0448e+03	8.3700e+01	7.3000e-02	3.1250e-01	3.4297e-04	2.4256e-05	-3.1871e-04	-9.2928e-01
3	1995	8	6	1	0	2.7000e+00	2.3000e-01	2.0308e+02	8.1500e+01	5.5300e-01	7.5000e-01	9.7800e-06	7.7754e-05	6.7974e-05	6.9503e+00
4	1995	8	6	1	30	2.7000e+00	6.3000e-01	3.3730e+02	8.1000e+01	1.2680e+00	7.5000e-01	3.3100e-06	5.0625e-05	4.7315e-05	1.4295e+01
5	1995	8	6	2	0	2.4000e+00	3.5000e-01	4.3494e+02	7.9600e+01	1.0600e-01	3.1250e-01	7.7370e-05	8.9883e-05	1.2513e-05	1.6173e-01
6	1995	8	6	2	30	2.9000e+00	2.3000e-01	2.0819e+02	7.9800e+01	7.5000e-02	3.1250e-01	1.1843e-04	1.2847e-04	1.0038e-05	8.4762e-02
7	1995	8	6	3	0	2.6000e+00	1.3000e-01	4.2206e+02	7.9600e+01	7.5000e-02	3.1250e-01	1.2830e-05	1.1610e-04	1.0327e-04	8.0494e+00
8	1995	8	6	3	30	2.7000e+00	1.7000e-01	2.6814e+02	7.8600e+01	1.3300e-01	3.1250e-01	2.1830e-05	1.1262e-04	9.0792e-05	4.1590e+00
9	1995	8	6	4	0	1.8000e+00	8.6000e-01	2.1451e+03	7.8400e+01	1.1900e-01	3.1250e-01	1.1810e-05	6.4438e-05	5.2628e-05	4.4562e+00
10	1995	8	7	1	0	3.0000e+00	1.6000e-01	2.4250e+01	8.0000e+01	2.7000e-02	1.0000e+00	6.0873e-04	1.3039e-04	-4.7834e-04	-7.8580e-01
11	1995	8	7	1	30	3.6000e+00	6.1000e-01	2.5380e+01	7.9100e+01	8.3000e-02	1.0000e+00	5.1979e-04	1.6333e-04	-3.5646e-04	-6.8579e-01
12	1995	8	7	2	0	5.8000e+00	9.0000e-02	1.0570e+01	7.8900e+01	1.0000e-03	1.0000e+00	7.1813e-04	5.4905e-04	-1.6908e-04	-2.3544e-01
13	1995	8	7	2	30	3.8000e+00	5.0000e-02	1.4050e+01	7.8500e+01	0.0000e+00	1.0000e+00	2.0527e-03	2.3869e-04	-1.8140e-03	-8.8372e-01
14	1995	8	7	3	0	6.0000e+00	1.4600e+00	4.7040e+01	7.8600e+01	8.0000e-03	1.0000e+00	1.0607e-03	4.9303e-04	-5.6764e-04	-5.3517e-01
15	1995	8	7	3	30	4.4000e+00	1.9200e+00	8.0640e+01	7.8800e+01	1.7000e-02	1.0000e+00	1.1372e-03	2.5256e-04	-8.8468e-04	-7.7792e-01
16	1995	8	7	4	0	4.2000e+00	1.1000e+00	1.8560e+01	7.8900e+01	7.0000e-03	3.1250e-01	6.2885e-04	2.3296e-04	-3.9589e-04	-6.2954e-01
17	1995	8	7	4	30	4.5000e+00	5.2000e-01	6.1040e+01	7.9200e+01	1.3000e-02	3.1250e-01	9.1170e-04	2.9352e-04	-6.1818e-04	-6.7805e-01
18	1995	8	7	5	0	4.8000e+00	1.6000e-01	2.2070e+01	7.9100e+01	1.5000e-02	3.1250e-01	8.1470e-04	3.5499e-04	-4.5971e-04	-5.6427e-01
19	1995	8	7	5	30	5.2000e+00	4.4000e-01	6.7690e+01	7.9300e+01	7.0000e-03	3.1250e-01	1.5719e-03	4.0792e-04	-1.1640e-03	-7.4050e-01
20	1995	8	7	6	0	5.9000e+00	5.1000e-01	7.5100e+00	7.9400e+01	1.0000e-02	3.1250e-01	1.3989e-03	4.9453e-04	-9.0434e-04	-6.4648e-01
21	1995	8	7	6	30	6.4000e+00	2.4500e+00	2.8531e+03	7.9500e+01	1.0200e-01	3.1250e-01	1.9479e-03	8.5100e-04	-1.0970e-03	-5.6313e-01
22	1995	8	7	7	0	6.8000e+00	2.1600e+00	3.1693e+02	7.9800e+01	1.3400e-01	3.1250e-01	9.2514e-04	6.3692e-04	-2.8822e-04	-3.1155e-01
23	1995	8	7	7	30	1.6000e+00	1.2500e+00	6.3050e+03	7.8500e+01	4.4000e-02	3.1250e-01	7.8005e-04	7.7716e-05	-7.0233e-04	-9.0037e-01
24	1995	8	7	8	0	5.1000e+00	5.7200e+00	4.2032e+02	7.8500e+01	1.4700e-01	7.5000e-01	1.6251e-03	3.2517e-04	-1.2999e-03	-7.9991e-01
25	1995	8	7	8	30	4.8000e+00	2.4200e+00	5.6540e+01	7.7800e+01	4.6000e-02	7.5000e-01	1.1227e-03	2.8894e-04	-8.3377e-04	-7.4264e-01
26	1995	8	7	9	0	4.2000e+00	1.6000e-01	9.4210e+01	7.8100e+01	1.0000e-02	7.5000e-01	5.2181e-04	2.8571e-04	-2.3610e-04	-4.5246e-01
27	1995	8	7	9	30	5.1000e+00	4.4000e-01	2.3640e+01	7.7900e+01	2.2000e-02	7.5000e-01	5.6692e-04	3.7183e-04	-1.9509e-04	-3.4412e-01
28	1995	8	7	10	0	6.0000e+00	4.0000e-01	1.6220e+01	7.7400e+01	1.3000e-02	1.0000e+00	1.0430e-03	5.3031e-04	-5.1267e-04	-4.9155e-01
29	1995	8	7	10	30	6.7000e+00	2.9000e-01	1.1510e+01	7.7000e+01	2.1000e-02	1.0000e+00	1.1448e-03	6.8262e-04	-4.6220e-04	-4.0373e-01
30	1995	8	9	1	0	3.4000e+00	3.1000e-01	6.6980e+01	8.5600e+01	2.2100e-01	3.1250e-01	5.2000e-06	1.3419e-04	1.2899e-04	2.4806e+01
31	1995	8	9	1	30	5.4000e+00	4.2500e+00	1.0730e+02	8.3800e+01	4.7300e-01	3.1250e-01	4.4681e-04	2.5530e-04	-1.9151e-04	-4.2861e-01
32	1995	8	9	2	0	8.3000e+00	9.8000e-01	1.8180e+01	8.2200e+01	1.7900e-01	3.1250e-01	1.5535e-03	8.4998e-04	-7.0356e-04	-4.5287e-01
33	1995	8	9	2	30	7.3000e+00	1.2000e+00	1.7040e+01	8.0900e+01	7.1000e-02	3.1250e-01	1.6943e-03	6.9407e-04	-1.0002e-03	-5.9035e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
34	1995	8	9	3	0	7.2000e+00	6.8000e-01	6.8500e+00	8.0100e+01	5.0000e-02	3.1250e-01	1.5835e-03	7.1074e-04	-8.7272e-04	-5.5115e-01
35	1995	8	9	3	30	5.9000e+00	1.8000e-01	1.8350e+01	7.9400e+01	4.6000e-02	3.1250e-01	9.9042e-04	5.2541e-04	-4.6501e-04	-4.6951e-01
36	1995	8	9	4	0	5.8000e+00	2.4000e-01	1.2450e+01	7.9000e+01	1.9000e-02	1.0000e+00	8.2890e-04	4.9873e-04	-3.3017e-04	-3.9833e-01
37	1995	8	9	4	30	7.0000e+00	3.6000e-01	1.5790e+01	7.8600e+01	3.2000e-02	1.0000e+00	9.8151e-04	7.2466e-04	-2.5685e-04	-2.6169e-01
38	1995	8	9	5	0	6.5000e+00	4.6000e-01	1.6440e+01	7.7900e+01	3.9000e-02	7.5000e-01	9.0968e-04	6.0859e-04	-3.0109e-04	-3.3099e-01
39	1995	8	9	5	30	5.8000e+00	8.1000e-01	2.6480e+01	7.7500e+01	2.8000e-02	7.5000e-01	7.6801e-04	4.6751e-04	-3.0050e-04	-3.9127e-01
40	1995	8	9	6	0	2.8000e+00	1.9000e+00	6.8791e+02	7.7000e+01	1.5000e-02	3.1250e-01	3.7134e-04	1.2658e-04	-2.4476e-04	-6.5913e-01
41	1995	8	9	6	30	3.2000e+00	3.6800e+00	2.9951e+03	7.6900e+01	1.0500e-01	3.1250e-01	1.0560e-03	2.0010e-04	-8.5593e-04	-8.1051e-01
42	1995	8	9	8	0	5.2000e+00	1.0900e+00	1.5964e+02	7.7000e+01	4.2000e-02	3.1250e-01	2.1506e-04	3.9400e-04	1.7894e-04	8.3203e-01
43	1995	8	9	8	30	7.1000e+00	5.2000e-01	8.9310e+01	7.7000e+01	2.1000e-02	3.1250e-01	9.0560e-04	8.0625e-04	-9.9355e-05	-1.0971e-01
44	1995	8	9	9	0	7.1000e+00	5.0800e+00	1.9110e+02	7.7200e+01	7.5000e-02	0.0000e+00	1.1491e-03	6.7871e-04	-4.7044e-04	-4.0938e-01
45	1995	8	9	9	30	2.7000e+00	1.4200e+00	2.7861e+02	7.7600e+01	2.5000e-02	0.0000e+00	4.2539e-04	1.0707e-04	-3.1832e-04	-7.4831e-01
46	1995	8	9	10	0	4.2000e+00	2.4700e+00	6.1060e+03	7.7100e+01	6.2000e-02	3.1250e-01	9.2825e-04	4.8605e-04	-4.4220e-04	-4.7638e-01
47	1995	8	9	10	30	3.5000e+00	5.3000e-01	1.6285e+02	7.7200e+01	1.7000e-02	3.1250e-01	2.1836e-04	1.8718e-04	-3.1178e-05	-1.4278e-01
48	1995	8	9	11	0	3.6000e+00	4.9000e-01	3.4010e+02	7.6700e+01	3.8000e-02	3.1250e-01	9.1050e-05	2.0912e-04	1.1807e-04	1.2968e+00
49	1995	8	10	1	0	4.3000e+00	2.3200e+00	3.6482e+02	7.6300e+01	4.2000e-02	7.5000e-01	4.4404e-04	2.6701e-04	-1.7703e-04	-3.9869e-01
50	1995	8	10	1	30	3.8000e+00	1.0900e+00	1.2830e+03	7.6000e+01	8.8000e-02	7.5000e-01	3.0749e-04	2.5494e-04	-5.2547e-05	-1.7089e-01
51	1995	8	10	2	0	2.4000e+00	2.8700e+00	2.6957e+03	7.5100e+01	9.1000e-02	7.5000e-01	2.4386e-04	1.1353e-04	-1.3033e-04	-5.3446e-01
52	1995	8	10	2	30	2.2000e+00	7.1000e-01	3.0855e+02	7.4600e+01	2.4000e-02	7.5000e-01	1.6832e-04	7.7201e-05	-9.1119e-05	-5.4134e-01
53	1995	8	10	3	0	3.1000e+00	1.3900e+00	4.9299e+03	7.4900e+01	1.7000e-02	7.5000e-01	7.6750e-05	2.6317e-04	1.8642e-04	2.4289e+00
54	1995	8	10	3	30	3.6000e+00	5.2000e+00	6.3850e+02	7.6000e+01	2.1800e-01	7.5000e-01	8.7381e-04	1.6244e-04	-7.1137e-04	-8.1410e-01
55	1995	8	10	4	0	6.3000e+00	1.2800e+00	3.2820e+01	7.5700e+01	4.3000e-02	7.5000e-01	1.1124e-03	5.4407e-04	-5.6829e-04	-5.1089e-01
56	1995	8	10	4	30	4.6000e+00	7.1000e-01	1.2743e+02	7.5300e+01	1.8000e-02	7.5000e-01	1.4207e-03	3.1856e-04	-1.1021e-03	-7.7577e-01
57	1995	8	10	5	0	2.9000e+00	7.0000e-01	9.3120e+01	7.5300e+01	1.5000e-02	7.5000e-01	9.4038e-04	1.2213e-04	-8.1825e-04	-8.7012e-01
58	1995	8	10	5	30	3.3000e+00	8.0000e-01	8.5310e+01	7.5500e+01	1.8000e-02	7.5000e-01	1.0514e-03	1.5522e-04	-8.9621e-04	-8.5237e-01
59	1995	8	10	6	0	2.1000e+00	1.6000e+00	7.5565e+03	7.5400e+01	1.1000e-02	7.5000e-01	4.8270e-04	1.4654e-04	-3.3616e-04	-6.9642e-01
60	1995	8	10	6	30	1.0000e+00	1.5500e+00	6.6182e+03	7.5400e+01	2.8000e-02	7.5000e-01	7.6580e-05	3.4310e-05	-4.2270e-05	-5.5198e-01
61	1995	8	10	7	0	1.8000e+00	1.7400e+00	5.2827e+02	7.4700e+01	8.3000e-02	7.5000e-01	1.1370e-05	4.9366e-05	3.7996e-05	3.3418e+00
62	1995	8	10	7	30	1.8000e+00	1.2000e-01	7.8763e+02	7.4100e+01	2.2000e-02	7.5000e-01	1.5480e-05	6.8307e-05	5.2827e-05	3.4126e+00
63	1995	8	10	8	0	1.9000e+00	6.7000e-01	8.3411e+02	7.4600e+01	3.3000e-01	7.5000e-01	2.9576e-04	5.2571e-05	-2.4319e-04	-8.2225e-01
64	1995	8	10	8	30	2.3000e+00	1.6300e+00	6.6924e+02	7.4100e+01	3.6000e-02	7.5000e-01	1.3020e-05	8.6012e-05	7.2992e-05	5.6061e+00
65	1995	8	10	9	0	3.4000e+00	3.2000e-01	9.0290e+01	7.4000e+01	7.0000e-03	3.1250e-01	3.2070e-05	1.8377e-04	1.5170e-04	4.7302e+00
66	1995	8	10	9	30	3.6000e+00	1.9000e+00	3.6740e+01	7.4200e+01	1.5000e-02	3.1250e-01	4.9520e-05	1.7116e-04	1.2164e-04	2.4565e+00

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
67	1995	8	10	10	0	1.6000e+00	8.4000e-01	1.5954e+03	7.4100e+01	5.0000e-03	3.1250e-01	2.7392e-04	5.5517e-05	-2.1840e-04	-7.9733e-01
68	1995	8	10	10	30	2.2000e+00	6.3000e-01	2.5644e+02	7.4100e+01	1.5000e-02	3.1250e-01	2.7181e-04	7.8374e-05	-1.9344e-04	-7.1166e-01
69	1995	8	10	11	0	2.2000e+00	5.1000e-01	1.5678e+02	7.3900e+01	1.0000e-02	3.1250e-01	4.9117e-04	7.7139e-05	-4.1403e-04	-8.4295e-01
70	1995	8	11	1	0	3.8000e+00	2.2000e-01	1.8996e+02	8.2100e+01	1.9800e-01	3.1250e-01	2.0353e-04	1.9595e-04	-7.5799e-06	-3.7242e-02
71	1995	8	11	1	30	2.6000e+00	3.1000e-01	1.2917e+03	8.2600e+01	3.6000e-02	3.1250e-01	2.5657e-04	1.2949e-04	-1.2708e-04	-4.9531e-01
72	1995	8	11	2	0	2.4000e+00	1.1400e+00	5.8969e+03	8.1300e+01	7.2600e-01	3.1250e-01	4.4320e-05	1.0104e-04	5.6723e-05	1.2798e+00
73	1995	8	11	2	30	1.1000e+00	5.0000e-01	4.8074e+03	8.0400e+01	6.9000e-02	3.1250e-01	1.0493e-04	3.5917e-05	-6.9013e-05	-6.5771e-01
74	1995	8	11	3	0	1.3000e+00	7.4000e-01	2.8489e+03	8.1500e+01	9.0000e-02	0.0000e+00	5.9700e-05	3.8438e-05	-2.1262e-05	-3.5614e-01
75	1995	8	11	3	30	1.6000e+00	3.4000e-01	1.0118e+03	8.0800e+01	4.6800e-01	0.0000e+00	1.9573e-04	3.6312e-05	-1.5942e-04	-8.1448e-01
76	1995	8	11	4	0	3.1000e+00	9.9000e-01	2.3595e+02	8.0300e+01	3.5900e-01	0.0000e+00	3.7311e-04	1.0793e-04	-2.6518e-04	-7.1072e-01
77	1995	8	11	4	30	4.7000e+00	3.6000e-01	5.1470e+01	7.9300e+01	4.2000e-02	0.0000e+00	4.0103e-04	3.2060e-04	-8.0427e-05	-2.0055e-01
78	1995	8	11	5	0	3.2000e+00	5.4000e-01	7.2290e+01	7.9200e+01	5.0000e-02	0.0000e+00	5.1134e-04	1.4192e-04	-3.6942e-04	-7.2246e-01
79	1995	8	11	5	30	2.4000e+00	8.1000e-01	2.3235e+02	7.9400e+01	9.6000e-02	0.0000e+00	4.2382e-04	8.0406e-05	-3.4341e-04	-8.1028e-01
80	1995	8	11	6	0	2.0000e+00	3.9000e-01	1.5127e+02	7.8300e+01	8.4000e-02	0.0000e+00	4.4520e-05	5.9035e-05	1.4515e-05	3.2602e-01
81	1995	8	11	6	30	2.9000e+00	1.8000e-01	1.1036e+02	7.8100e+01	3.1000e-02	0.0000e+00	1.4644e-04	1.3348e-04	-1.2963e-05	-8.8523e-02
82	1995	8	11	7	0	2.2000e+00	5.2000e-01	6.2914e+02	7.7800e+01	3.4000e-02	0.0000e+00	2.3677e-04	8.4265e-05	-1.5251e-04	-6.4411e-01
83	1995	8	11	7	30	2.1000e+00	7.8000e-01	1.8054e+02	7.7800e+01	7.2000e-02	0.0000e+00	1.0964e-04	6.3193e-05	-4.6447e-05	-4.2363e-01
84	1995	8	11	8	0	1.0000e+00	3.8000e-01	6.5221e+03	7.7900e+01	4.0000e-02	0.0000e+00	2.6950e-04	3.7329e-05	-2.3217e-04	-8.6149e-01
85	1995	8	11	8	30	1.5000e+00	4.9000e-01	1.5400e+03	7.8300e+01	1.3000e-02	0.0000e+00	8.9190e-05	4.8915e-05	-4.0275e-05	-4.5156e-01
86	1995	8	11	9	0	2.5000e+00	2.5000e-01	1.3524e+02	7.7700e+01	8.9000e-02	3.1250e-01	7.5310e-05	9.3005e-05	1.7695e-05	2.3497e-01
87	1995	8	11	9	30	1.0000e+00	3.4000e-01	2.3356e+03	7.7200e+01	7.0000e-03	3.1250e-01	3.5104e-04	2.7009e-05	-3.2403e-04	-9.2306e-01
88	1995	8	11	10	0	9.0000e-01	3.0000e-01	4.4561e+03	7.6900e+01	1.4200e-01	3.1250e-01	1.1779e-04	2.4787e-05	-9.3003e-05	-7.8957e-01
89	1995	8	11	10	30	6.0000e-01	1.3000e-01	6.3329e+03	7.6900e+01	5.4000e-02	3.1250e-01	1.3120e-05	1.6394e-05	3.2739e-06	2.4953e-01
90	1995	8	11	11	0	8.0000e-01	3.6000e-01	5.8559e+03	7.6900e+01	1.0000e-02	3.1250e-01	1.3560e-05	2.4997e-05	1.1437e-05	8.4345e-01
91	1995	8	12	1	0	2.2000e+00	1.2000e-01	1.0731e+03	8.8300e+01	2.4900e-01	0.0000e+00	3.8380e-05	7.6233e-05	3.7853e-05	9.8627e-01
92	1995	8	12	1	30	4.7000e+00	3.0200e+00	3.0423e+02	8.5800e+01	1.3680e+00	0.0000e+00	3.1700e-04	1.2504e-04	-1.9196e-04	-6.0557e-01
93	1995	8	12	2	0	3.7000e+00	5.9100e+00	1.0209e+03	8.3600e+01	9.5000e-02	0.0000e+00	2.0178e-04	1.8916e-04	-1.2618e-05	-6.2535e-02
94	1995	8	12	2	30	2.1000e+00	2.8100e+00	2.7299e+03	8.2500e+01	5.2600e-01	0.0000e+00	5.6230e-05	6.1645e-05	5.4146e-06	9.6294e-02
95	1995	8	12	3	0	4.4000e+00	2.5000e-01	3.4220e+01	8.0700e+01	5.1000e-02	0.0000e+00	1.0772e-04	2.7637e-04	1.6865e-04	1.5656e+00
96	1995	8	12	3	30	3.8000e+00	1.3000e-01	3.3010e+01	7.9700e+01	2.1900e-01	0.0000e+00	3.4247e-04	1.8970e-04	-1.5277e-04	-4.4609e-01
97	1995	8	12	4	0	3.0000e+00	1.0400e+00	1.6611e+03	7.8900e+01	1.3100e-01	0.0000e+00	1.0620e-04	1.6000e-04	5.3801e-05	5.0660e-01
98	1995	8	12	4	30	1.7000e+00	8.0000e-02	2.1930e+02	7.9800e+01	1.4000e-02	0.0000e+00	2.4882e-04	5.3028e-05	-1.9579e-04	-7.8688e-01
99	1995	8	12	5	0	2.9000e+00	2.4000e-01	1.3489e+02	7.9500e+01	7.7000e-02	0.0000e+00	1.9598e-04	1.2502e-04	-7.0957e-05	-3.6206e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
100	1995	8	12	5	30	2.2000e+00	2.6000e-01	2.9579e+02	7.9100e+01	2.6000e-02	0.0000e+00	2.0388e-04	8.0929e-05	-1.2295e-04	-6.0306e-01
101	1995	8	12	6	0	1.2000e+00	3.9000e-01	3.6108e+02	7.8500e+01	7.7000e-02	0.0000e+00	3.4020e-05	2.4686e-05	-9.3345e-06	-2.7438e-01
102	1995	8	12	6	30	1.7000e+00	3.9000e-01	9.4260e+01	7.7700e+01	3.5600e-01	0.0000e+00	1.1934e-04	3.4763e-05	-8.4577e-05	-7.0871e-01
103	1995	8	12	8	0	4.0000e-01	1.5000e-01	7.0658e+03	7.6600e+01	1.0600e-01	0.0000e+00	2.0400e-06	8.4645e-06	6.4245e-06	3.1492e+00
104	1995	8	12	8	30	7.0000e-01	5.1000e-01	5.8330e+03	7.6800e+01	2.5000e-02	0.0000e+00	6.8400e-06	1.9132e-05	1.2292e-05	1.7970e+00
105	1995	8	12	9	0	2.9000e+00	3.6000e-01	1.4495e+02	7.6100e+01	1.7200e-01	0.0000e+00	4.3890e-05	1.1662e-04	7.2731e-05	1.6571e+00
106	1995	8	12	9	30	2.1000e+00	4.0000e-01	1.7640e+01	7.6500e+01	7.1000e-02	0.0000e+00	6.2400e-06	6.0690e-05	5.4450e-05	8.7259e+00
107	1995	8	12	10	0	2.1000e+00	2.1000e-01	2.8310e+01	7.6000e+01	1.3500e-01	3.1250e-01	4.6800e-06	6.1188e-05	5.6508e-05	1.2074e+01
108	1995	8	12	10	30	1.1000e+00	1.0000e+00	5.8275e+03	7.5400e+01	6.3000e-02	3.1250e-01	8.1800e-06	3.8850e-05	3.0670e-05	3.7493e+00
109	1995	8	12	11	0	1.1000e+00	9.2000e-01	1.6440e+03	7.5400e+01	1.1200e-01	3.1250e-01	1.4170e-05	2.5020e-05	1.0850e-05	7.6571e-01
110	1995	8	14	1	0	3.6000e+00	5.0000e-02	1.4737e+02	8.7200e+01	6.5700e-01	3.1250e-01	2.5500e-06	1.3407e-04	1.3152e-04	5.1577e+01
111	1995	8	14	1	30	3.5000e+00	5.0000e-02	4.1930e+01	8.6800e+01	4.3000e-02	3.1250e-01	5.8000e-07	1.8193e-04	1.8135e-04	3.1268e+02
112	1995	8	14	2	0	3.3000e+00	6.0000e-02	8.1200e+00	8.6100e+01	7.1000e-02	3.1250e-01	2.1000e-07	1.5050e-04	1.5029e-04	7.1566e+02
113	1995	8	14	2	30	5.4000e+00	5.6300e+00	8.4835e+02	8.4600e+01	1.7900e-01	3.1250e-01	1.0268e-03	3.7278e-04	-6.5398e-04	-6.3693e-01
114	1995	8	14	3	0	5.7000e+00	7.3000e-01	6.1560e+01	8.3600e+01	5.7000e-02	0.0000e+00	9.0938e-04	4.3308e-04	-4.7630e-04	-5.2376e-01
115	1995	8	14	3	30	3.9000e+00	1.4200e+00	3.8524e+02	8.2600e+01	2.6100e-01	0.0000e+00	5.5050e-04	1.8300e-04	-3.6750e-04	-6.6757e-01
116	1995	8	14	4	0	3.2000e+00	1.6500e+00	7.8605e+02	8.1100e+01	2.3000e-02	0.0000e+00	4.6642e-04	1.6343e-04	-3.0299e-04	-6.4961e-01
117	1995	8	14	4	30	2.5000e+00	4.0600e+00	8.0942e+03	8.0400e+01	1.7300e-01	0.0000e+00	3.0638e-04	1.6709e-04	-1.3929e-04	-4.5464e-01
118	1995	8	14	5	0	2.6000e+00	4.3000e-01	2.4375e+02	8.0000e+01	1.4900e-01	0.0000e+00	5.9020e-05	9.4539e-05	3.5519e-05	6.0181e-01
119	1995	8	14	5	30	2.3000e+00	3.8000e-01	1.5061e+02	7.9300e+01	3.3000e-02	0.0000e+00	1.9962e-04	8.0303e-05	-1.1932e-04	-5.9772e-01
120	1995	8	14	6	0	5.1000e+00	1.1800e+00	9.2639e+02	7.9200e+01	1.3400e-01	0.0000e+00	1.7712e-04	4.1908e-04	2.4196e-04	1.3661e+00
121	1995	8	14	6	30	5.0000e+00	8.4000e-01	7.0790e+01	7.8500e+01	3.5000e-02	0.0000e+00	3.6565e-04	3.5226e-04	-1.3389e-05	-3.6616e-02
122	1995	8	14	7	0	5.1000e+00	2.8000e-01	4.5500e+01	7.8200e+01	1.0300e-01	0.0000e+00	5.3335e-04	3.7065e-04	-1.6270e-04	-3.0506e-01
123	1995	8	14	7	30	4.5000e+00	2.6000e-01	1.7360e+01	7.8100e+01	1.4000e-02	0.0000e+00	7.7457e-04	3.0199e-04	-4.7258e-04	-6.1011e-01
124	1995	8	14	8	0	4.1000e+00	3.2000e-01	7.1640e+01	7.7700e+01	1.1600e-01	0.0000e+00	5.9327e-04	2.3524e-04	-3.5803e-04	-6.0348e-01
125	1995	8	14	8	30	5.2000e+00	3.4000e-01	3.7290e+01	7.7800e+01	6.1000e-02	0.0000e+00	8.9416e-04	3.9298e-04	-5.0118e-04	-5.6050e-01
126	1995	8	14	9	0	4.3000e+00	2.3000e-01	5.0190e+01	7.7000e+01	1.7000e-02	0.0000e+00	2.8217e-04	2.8851e-04	6.3418e-06	2.2475e-02
127	1995	8	14	9	30	3.6000e+00	4.2000e-01	2.5770e+02	7.6900e+01	1.6000e-02	0.0000e+00	5.1692e-04	2.1169e-04	-3.0523e-04	-5.9048e-01
128	1995	8	14	10	0	2.9000e+00	2.2000e-01	9.0600e+01	7.6600e+01	3.5000e-02	3.1250e-01	4.6880e-04	1.3041e-04	-3.3839e-04	-7.2182e-01
129	1995	8	14	10	30	2.3000e+00	1.1000e-01	7.0160e+01	7.6100e+01	2.0000e-02	3.1250e-01	2.1222e-04	8.7719e-05	-1.2450e-04	-5.8666e-01
130	1995	8	14	11	0	1.9000e+00	3.1000e-01	7.2340e+01	7.5800e+01	2.9000e-02	3.1250e-01	2.3963e-04	5.5754e-05	-1.8388e-04	-7.6733e-01
131	1995	8	15	1	0	2.9000e+00	2.5000e-01	2.4669e+02	8.5300e+01	6.1700e-01	0.0000e+00	1.5070e-05	8.4402e-05	6.9332e-05	4.6007e+00
132	1995	8	15	1	30	3.9000e+00	1.2000e-01	6.4750e+01	8.4000e+01	5.2000e-02	0.0000e+00	1.3050e-05	2.2420e-04	2.1115e-04	1.6180e+01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
133	1995	8	15	2	0	4.1000e+00	1.7000e-01	1.4800e+01	8.3600e+01	1.6400e-01	0.0000e+00	8.9510e-05	2.1179e-04	1.2228e-04	1.3661e+00
134	1995	8	15	2	30	5.0000e+00	2.3000e-01	2.4770e+01	8.3000e+01	9.2000e-02	0.0000e+00	2.0464e-04	3.3867e-04	1.3403e-04	6.5496e-01
135	1995	8	15	3	0	4.6000e+00	2.7000e-01	2.3980e+01	8.2200e+01	6.1000e-02	0.0000e+00	1.0420e-04	2.9062e-04	1.8642e-04	1.7890e+00
136	1995	8	15	3	30	5.4000e+00	3.3000e-01	9.3330e+01	8.2300e+01	3.7000e-02	0.0000e+00	1.8979e-04	4.3323e-04	2.4344e-04	1.2827e+00
137	1995	8	15	4	0	4.8000e+00	3.2000e-01	1.0000e+01	8.1600e+01	8.8000e-02	0.0000e+00	3.0254e-04	3.0265e-04	1.1357e-07	3.7540e-04
138	1995	8	15	4	30	5.0000e+00	2.2000e-01	1.9990e+01	8.1200e+01	9.0000e-03	0.0000e+00	2.3059e-04	3.7333e-04	1.4274e-04	6.1900e-01
139	1995	8	15	5	0	4.3000e+00	3.4000e-01	3.9940e+01	8.0900e+01	1.6000e-01	3.1250e-01	4.7985e-04	2.3452e-04	-2.4533e-04	-5.1127e-01
140	1995	8	15	5	30	3.9000e+00	2.2000e-01	2.5430e+01	8.0400e+01	2.6000e-02	3.1250e-01	2.5272e-04	2.1985e-04	-3.2873e-05	-1.3008e-01
141	1995	8	15	7	0	3.4000e+00	1.8000e-01	4.1520e+01	7.8900e+01	8.2000e-02	3.1250e-01	5.6800e-06	1.6528e-04	1.5960e-04	2.8098e+01
142	1995	8	15	7	30	3.3000e+00	2.2000e-01	1.4873e+02	7.8400e+01	2.0000e-01	3.1250e-01	5.4130e-05	1.4994e-04	9.5805e-05	1.7699e+00
143	1995	8	15	8	0	3.1000e+00	1.4000e-01	5.0200e+01	7.8300e+01	2.6000e-02	3.1250e-01	5.1280e-05	1.4915e-04	9.7872e-05	1.9086e+00
144	1995	8	15	8	30	4.2000e+00	3.6000e-01	1.1997e+02	7.8700e+01	1.3700e-01	3.1250e-01	2.5094e-04	2.4402e-04	-6.9196e-06	-2.7575e-02
145	1995	8	16	1	0	2.4000e+00	9.0000e-02	2.4472e+02	8.6200e+01	3.0000e-02	0.0000e+00	7.0160e-05	9.3406e-05	2.3246e-05	3.3132e-01
146	1995	8	16	1	30	2.3000e+00	9.0000e-02	2.9966e+02	8.4500e+01	7.3800e-01	0.0000e+00	2.2540e-05	5.5427e-05	3.2887e-05	1.4591e+00
147	1995	8	16	2	0	2.1000e+00	2.1000e-01	2.0853e+02	8.4500e+01	3.9100e-01	0.0000e+00	8.6000e-07	5.2101e-05	5.1241e-05	5.9583e+01
148	1995	8	16	2	30	2.9000e+00	2.0000e-01	1.3240e+02	8.2800e+01	2.5600e-01	0.0000e+00	3.0000e-07	1.0656e-04	1.0626e-04	3.5420e+02
149	1995	8	16	3	0	3.4000e+00	5.9000e-01	1.4164e+02	8.2400e+01	1.5300e-01	0.0000e+00	1.3500e-06	1.4687e-04	1.4552e-04	1.0779e+02
150	1995	8	16	3	30	1.3000e+00	6.1000e-01	3.0394e+03	8.1400e+01	1.7400e-01	0.0000e+00	2.0100e-06	3.7311e-05	3.5301e-05	1.7563e+01
151	1995	8	16	4	0	2.5000e+00	5.0000e-01	5.1979e+02	8.2100e+01	1.8600e-01	0.0000e+00	5.7107e-04	8.9175e-05	-4.8190e-04	-8.4385e-01
152	1995	8	16	4	30	4.5000e+00	3.5000e-01	4.6060e+01	8.1800e+01	1.1250e+00	0.0000e+00	6.5710e-05	1.4304e-04	7.7328e-05	1.1768e+00
153	1995	8	16	5	0	2.1000e+00	5.9000e-01	5.3288e+02	8.0200e+01	1.6130e+00	3.1250e-01	3.6390e-05	2.7975e-05	-8.4155e-06	-2.3126e-01
154	1995	8	16	5	30	1.5000e+00	2.5000e-01	4.7960e+02	8.0300e+01	4.6300e-01	3.1250e-01	5.8110e-05	2.9530e-05	-2.8580e-05	-4.9182e-01
155	1995	8	16	6	0	1.5000e+00	3.0000e-01	9.7704e+02	7.8500e+01	1.1200e+00	3.1250e-01	2.3900e-05	2.2550e-05	-1.3504e-06	-5.6504e-02
156	1995	8	16	6	30	1.9000e+00	3.7000e-01	2.3060e+02	7.8700e+01	3.6600e-01	3.1250e-01	6.9700e-06	4.4819e-05	3.7849e-05	5.4303e+00
157	1995	8	16	9	0	1.6000e+00	4.2000e-01	3.7738e+02	7.7500e+01	1.2600e-01	3.1250e-01	5.7770e-05	4.0355e-05	-1.7415e-05	-3.0146e-01
158	1995	8	16	9	30	1.7000e+00	1.8000e-01	4.6517e+02	7.7300e+01	3.0300e-01	3.1250e-01	2.4060e-05	4.3596e-05	1.9536e-05	8.1196e-01
159	1995	8	16	11	0	8.0000e-01	1.7000e-01	3.1346e+03	7.8000e+01	1.4000e-02	3.1250e-01	7.6000e-07	2.0681e-05	1.9921e-05	2.6212e+01
160	1995	8	17	2	0	2.8000e+00	1.0400e+00	6.5480e+01	8.6700e+01	2.8000e-01	0.0000e+00	5.2000e-05	7.8567e-05	2.6567e-05	5.1090e-01
161	1995	8	17	2	30	1.6000e+00	3.7000e-01	4.9912e+02	8.5200e+01	6.4000e-02	0.0000e+00	1.3590e-05	4.0890e-05	2.7300e-05	2.0088e+00
162	1995	8	17	3	0	1.9000e+00	1.4000e-01	1.7478e+02	8.4800e+01	3.2000e-02	0.0000e+00	6.8410e-05	5.6942e-05	-1.1468e-05	-1.6763e-01
163	1995	8	17	3	30	3.0000e+00	2.2000e-01	5.4980e+01	8.5500e+01	4.3500e-01	0.0000e+00	1.1484e-04	9.2657e-05	-2.2183e-05	-1.9317e-01
164	1995	8	17	5	0	4.2000e+00	1.0000e-01	3.5390e+01	8.5000e+01	1.0700e-01	3.1250e-01	1.2594e-04	2.4221e-04	1.1627e-04	9.2321e-01
165	1995	8	17	5	30	2.2000e+00	1.2900e+00	4.8046e+02	8.3300e+01	5.0500e-01	3.1250e-01	7.6880e-05	5.0612e-05	-2.6268e-05	-3.4168e-01

continued

DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
166	1995	8	17	6	0	8.0000e-01	1.0000e-01	3.4596e+02	8.2600e+01	1.3100e-01	3.1250e-01	3.4220e-05	1.2101e-05	-2.2119e-05	-6.4637e-01
167	1995	8	17	6	30	9.0000e-01	2.8000e-01	2.6933e+03	8.1400e+01	1.4000e-01	3.1250e-01	3.2900e-06	2.0152e-05	1.6862e-05	5.1252e+00
168	1995	8	17	7	0	1.5000e+00	1.0200e+00	5.0022e+03	8.0600e+01	4.6600e-01	3.1250e-01	1.4320e-05	4.5834e-05	3.1514e-05	2.2007e+00
169	1995	8	17	7	30	2.0000e+00	1.8000e-01	1.1516e+03	8.0400e+01	3.1500e-01	3.1250e-01	1.1960e-05	6.5673e-05	5.3713e-05	4.4910e+00
170	1995	8	17	11	0	1.2000e+00	1.5000e-01	1.3104e+02	7.8900e+01	6.9000e-02	3.1250e-01	4.9800e-05	2.4310e-05	-2.5490e-05	-5.1186e-01
171	1995	8	18	1	0	1.4000e+00	3.1000e-01	5.9027e+02	8.4400e+01	5.1000e-02	0.0000e+00	2.7910e-05	3.3824e-05	5.9137e-06	2.1188e-01
172	1995	8	18	1	30	2.8000e+00	4.0000e-02	3.3330e+01	8.4400e+01	1.5000e-01	0.0000e+00	1.0510e-05	1.1158e-04	1.0107e-04	9.6162e+00
173	1995	8	18	2	0	3.3000e+00	1.3000e-01	4.7100e+00	8.4300e+01	2.1000e-02	0.0000e+00	5.1000e-07	1.5217e-04	1.5166e-04	2.9738e+02
174	1995	8	18	2	30	3.3000e+00	9.0000e-02	1.5180e+01	8.4400e+01	3.5300e-01	0.0000e+00	2.7900e-06	1.2371e-04	1.2092e-04	4.3340e+01
175	1995	8	18	4	0	3.3000e+00	3.4000e-01	6.7600e+01	8.5600e+01	1.2980e+00	0.0000e+00	2.2027e-04	6.6817e-05	-1.5345e-04	-6.9666e-01
176	1995	8	18	4	30	3.8000e+00	2.7000e-01	1.0870e+01	8.5600e+01	1.0200e+00	0.0000e+00	1.8895e-04	9.9647e-05	-8.9303e-05	-4.7263e-01
177	1995	8	18	5	0	3.8000e+00	2.1000e-01	2.8350e+01	8.5200e+01	7.8500e-01	0.0000e+00	3.7460e-04	1.1933e-04	-2.5527e-04	-6.8145e-01
178	1995	8	18	5	30	4.0000e+00	4.3000e-01	3.6060e+01	8.5400e+01	3.9000e-01	0.0000e+00	4.3156e-04	1.6031e-04	-2.7125e-04	-6.2853e-01
179	1995	8	18	7	0	9.0000e-01	5.2000e-01	5.9651e+03	8.0800e+01	2.6900e-01	0.0000e+00	3.2600e-06	2.3617e-05	2.0357e-05	6.2446e+00
180	1995	8	18	7	30	1.6000e+00	3.5000e-01	1.0249e+03	8.0100e+01	9.5000e-02	0.0000e+00	7.7650e-05	4.7461e-05	-3.0189e-05	-3.8878e-01
181	1995	8	18	10	0	3.0000e-01	8.0000e-02	8.3305e+03	7.9800e+01	4.2000e-02	3.1250e-01	1.8170e-05	6.2300e-06	-1.1940e-05	-6.5713e-01
182	1995	8	18	10	30	1.3000e+00	1.4000e-01	2.4235e+02	7.8700e+01	1.0000e-01	3.1250e-01	1.5430e-05	2.8914e-05	1.3484e-05	8.7389e-01
183	1995	8	19	3	0	2.3000e+00	2.5000e-01	5.6692e+02	8.6400e+01	5.6900e-01	0.0000e+00	1.3610e-04	5.9383e-05	-7.6717e-05	-5.6368e-01
184	1995	8	19	3	30	2.5000e+00	7.0000e-02	1.5973e+02	8.7300e+01	5.0000e-01	0.0000e+00	1.8814e-04	6.9945e-05	-1.1819e-04	-6.2823e-01
185	1995	8	19	5	0	1.7000e+00	3.5000e-01	2.9292e+02	8.7000e+01	1.8100e-01	0.0000e+00	1.2424e-04	3.8502e-05	-8.5738e-05	-6.9010e-01
186	1995	8	19	5	30	2.1000e+00	4.9000e-01	3.4829e+02	8.6700e+01	1.9900e-01	0.0000e+00	1.0466e-04	5.6593e-05	-4.8067e-05	-4.5927e-01
187	1995	8	20	1	0	4.7000e+00	1.2800e+00	2.9384e+02	8.8900e+01	2.4400e-01	0.0000e+00	5.3816e-04	2.4506e-04	-2.9310e-04	-5.4463e-01
188	1995	8	20	1	30	3.3000e+00	2.4400e+00	2.8182e+03	8.6400e+01	1.6090e+00	0.0000e+00	4.8899e-04	8.0255e-05	-4.0874e-04	-8.3588e-01
189	1995	8	20	3	0	3.3000e+00	2.2500e+00	9.4433e+02	8.4400e+01	4.2000e-02	0.0000e+00	1.5501e-04	1.6505e-04	1.0040e-05	6.4768e-02
190	1995	8	20	3	30	2.2000e+00	1.5000e+00	1.9496e+03	8.3000e+01	1.8530e+00	0.0000e+00	1.4660e-05	3.1232e-05	1.6572e-05	1.1304e+00
191	1995	8	20	5	0	2.9000e+00	1.2000e-01	8.8020e+01	8.0900e+01	3.2000e-01	1.0000e+00	2.9800e-06	1.0356e-04	1.0058e-04	3.3753e+01
192	1995	8	20	5	30	3.7000e+00	2.6000e-01	1.2817e+02	7.9400e+01	7.1000e-02	1.0000e+00	2.6900e-05	1.9953e-04	1.7263e-04	6.4173e+00
193	1995	8	20	6	0	2.5000e+00	2.4000e-01	3.6186e+02	7.8700e+01	5.1000e-02	7.5000e-01	2.7300e-06	1.0285e-04	1.0012e-04	3.6673e+01
194	1995	8	20	6	30	1.8000e+00	5.0000e-01	5.2704e+03	7.8600e+01	7.9000e-02	7.5000e-01	3.6580e-05	9.2409e-05	5.5829e-05	1.5262e+00
195	1995	8	21	4	0	2.1000e+00	1.0000e-01	1.5480e+01	8.3400e+01	1.3000e-02	3.1250e-01	6.4110e-05	6.5784e-05	1.6738e-06	2.6108e-02
196	1995	8	21	4	30	2.4000e+00	2.3000e-01	1.3032e+02	8.2700e+01	2.2200e-01	3.1250e-01	9.8040e-05	7.3826e-05	-2.4214e-05	-2.4698e-01
197	1995	8	21	5	0	3.7000e+00	4.4000e-01	1.9290e+01	8.2800e+01	6.3000e-02	0.0000e+00	1.6288e-04	1.7554e-04	1.2656e-05	7.7701e-02
198	1995	8	21	5	30	4.6000e+00	3.6000e-01	1.8700e+01	8.2500e+01	2.7000e-02	0.0000e+00	2.6925e-04	2.9062e-04	2.1367e-05	7.9356e-02

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DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
199	1995	8	21	6	0	4.2000e+00	9.2000e-01	5.5170e+01	8.2300e+01	5.9000e-02	3.1250e-01	1.0682e-04	2.2368e-04	1.1686e-04	1.0940e+00
200	1995	8	21	6	30	3.3000e+00	3.1000e-01	2.3130e+01	8.2200e+01	3.1000e-02	3.1250e-01	1.0882e-04	1.4799e-04	3.9167e-05	3.5993e-01
201	1995	8	21	9	0	4.7000e+00	8.4000e-01	3.2430e+01	7.9600e+01	9.0000e-03	7.5000e-01	1.6865e-04	2.9987e-04	1.3122e-04	7.7808e-01
202	1995	8	21	9	30	5.3000e+00	5.6000e-01	2.1990e+01	7.9300e+01	1.2000e-02	7.5000e-01	2.0618e-04	3.9437e-04	1.8819e-04	9.1274e-01
203	1995	8	22	2	0	5.0000e+00	5.8000e-01	1.3270e+01	8.5200e+01	6.0000e-03	0.0000e+00	3.8733e-04	3.2783e-04	-5.9498e-05	-1.5361e-01
204	1995	8	22	2	30	6.0000e+00	3.8000e-01	1.2260e+01	8.5100e+01	7.0000e-03	0.0000e+00	4.1007e-04	4.9964e-04	8.9575e-05	2.1844e-01
205	1995	8	22	6	0	4.3000e+00	7.2000e-01	6.2050e+01	8.1600e+01	6.8000e-02	0.0000e+00	9.6188e-04	2.4222e-04	-7.1966e-04	-7.4818e-01
206	1995	8	22	6	30	3.5000e+00	2.5000e-01	4.9260e+01	8.1200e+01	7.0000e-03	0.0000e+00	3.4653e-04	1.8176e-04	-1.6477e-04	-4.7550e-01
207	1995	8	22	8	0	6.9000e+00	8.0000e-01	4.3810e+01	8.0600e+01	2.0000e-02	0.0000e+00	1.5217e-03	6.8965e-04	-8.3206e-04	-5.4679e-01
208	1995	8	22	8	30	5.6000e+00	4.1000e-01	6.2230e+01	8.0300e+01	2.4000e-02	0.0000e+00	1.5876e-03	4.6774e-04	-1.1199e-03	-7.0538e-01
209	1995	8	22	11	0	5.0000e+00	5.8000e-01	5.6730e+01	7.8800e+01	9.0000e-03	3.1250e-01	7.9313e-04	3.6550e-04	-4.2763e-04	-5.3916e-01
210	1995	8	24	0	30	5.7000e+00	3.6000e-01	1.2010e+01	8.3100e+01	1.2200e-01	0.0000e+00	3.6356e-04	4.1474e-04	5.1179e-05	1.4077e-01
211	1995	8	24	2	0	4.7000e+00	1.1000e-01	9.6300e+00	7.9900e+01	3.1000e-02	0.0000e+00	1.5030e-04	3.3699e-04	1.8669e-04	1.2421e+00
212	1995	8	24	2	30	4.1000e+00	2.5000e-01	2.0230e+01	7.9100e+01	8.5000e-02	0.0000e+00	4.1493e-04	2.3194e-04	-1.8299e-04	-4.4100e-01
213	1995	8	24	3	0	3.4000e+00	2.8000e-01	4.6850e+01	7.8400e+01	8.8000e-02	0.0000e+00	6.4653e-04	1.6151e-04	-4.8502e-04	-7.5020e-01
214	1995	8	24	3	30	3.8000e+00	2.2000e-01	6.2970e+01	7.7800e+01	1.8000e-02	0.0000e+00	6.3910e-04	2.2440e-04	-4.1470e-04	-6.4889e-01
215	1995	8	24	5	0	4.2000e+00	2.7000e-01	1.5291e+02	7.6800e+01	2.9000e-02	3.1250e-01	1.3429e-03	2.8311e-04	-1.0598e-03	-7.8919e-01
216	1995	8	24	5	30	3.3000e+00	2.1000e-01	2.9810e+01	7.6500e+01	4.3000e-02	3.1250e-01	5.6834e-04	1.6099e-04	-4.0735e-04	-7.1673e-01
217	1995	8	24	9	0	4.3000e+00	1.5100e+00	4.3870e+01	7.2100e+01	5.3000e-02	0.0000e+00	2.8487e-04	2.4909e-04	-3.5778e-05	-1.2560e-01
218	1995	8	24	9	30	4.2000e+00	2.4000e-01	1.1850e+01	7.1500e+01	3.5000e-02	0.0000e+00	1.0399e-04	2.6925e-04	1.6526e-04	1.5892e+00
219	1995	8	24	11	0	4.1000e+00	4.7000e-01	1.0714e+02	7.2000e+01	1.3000e-02	0.0000e+00	2.6491e-04	2.6817e-04	3.2557e-06	1.2290e-02
220	1995	8	25	0	30	3.9000e+00	1.5000e-01	2.1460e+01	8.6700e+01	6.7000e-02	0.0000e+00	2.8370e-04	2.0159e-04	-8.2108e-05	-2.8942e-01
221	1995	8	25	1	0	4.2000e+00	4.4000e-01	3.3880e+01	8.6200e+01	6.3000e-02	0.0000e+00	3.0427e-04	2.2157e-04	-8.2702e-05	-2.7180e-01
222	1995	8	25	1	30	3.6000e+00	4.9000e-01	2.5580e+01	8.5500e+01	2.1400e-01	0.0000e+00	2.4449e-04	1.4228e-04	-1.0221e-04	-4.1803e-01
223	1995	8	25	2	0	3.6000e+00	3.4000e-01	1.8680e+01	8.4300e+01	5.3000e-02	0.0000e+00	3.3149e-04	1.6750e-04	-1.6399e-04	-4.9470e-01
224	1995	8	25	2	30	3.2000e+00	1.1000e-01	2.4210e+01	8.3800e+01	4.9000e-02	0.0000e+00	4.9976e-04	1.4632e-04	-3.5344e-04	-7.0722e-01
225	1995	8	25	3	0	2.2000e+00	8.6000e-01	6.6260e+01	8.3000e+01	1.6300e-01	0.0000e+00	3.6436e-04	5.6813e-05	-3.0755e-04	-8.4408e-01
226	1995	8	25	3	30	3.6000e+00	2.9000e-01	3.8560e+01	8.2900e+01	1.0000e-01	0.0000e+00	5.0262e-04	1.6934e-04	-3.3328e-04	-6.6308e-01
227	1995	8	25	4	0	4.1000e+00	3.4000e-01	2.4460e+01	8.2300e+01	7.1000e-02	0.0000e+00	1.1655e-03	2.2247e-04	-9.4300e-04	-8.0912e-01
228	1995	8	25	4	30	3.9000e+00	4.9000e-01	8.5600e+00	8.1800e+01	1.1900e-01	0.0000e+00	1.4485e-03	1.8427e-04	-1.2643e-03	-8.7279e-01
229	1995	8	25	5	0	4.5000e+00	2.5000e-01	1.1360e+01	8.1600e+01	3.5000e-02	0.0000e+00	1.9922e-03	2.8307e-04	-1.7091e-03	-8.5791e-01
230	1995	8	25	5	30	4.1000e+00	4.2000e-01	6.3550e+01	8.1200e+01	5.1000e-02	0.0000e+00	1.5469e-03	2.3351e-04	-1.3134e-03	-8.4905e-01
231	1995	8	25	6	0	3.2000e+00	1.1000e-01	2.8380e+01	8.0800e+01	5.0000e-03	0.0000e+00	1.9298e-03	1.5954e-04	-1.7703e-03	-9.1733e-01

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DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
232	1995	8	26	0	30	4.9000e+00	5.8000e-01	3.9450e+01	8.7700e+01	3.6000e-02	0.0000e+00	5.5319e-04	3.0207e-04	-2.5112e-04	-4.5395e-01
233	1995	8	26	1	0	5.0000e+00	6.3000e-01	4.9680e+01	8.7500e+01	2.7000e-02	0.0000e+00	7.1240e-04	3.1980e-04	-3.9260e-04	-5.5109e-01
234	1995	8	26	1	30	5.1000e+00	5.9000e-01	1.1480e+01	8.6600e+01	1.6000e-01	0.0000e+00	3.4412e-04	2.9135e-04	-5.2775e-05	-1.5336e-01
235	1995	8	26	2	0	3.4000e+00	1.0700e+00	1.9900e+01	8.5600e+01	8.8000e-02	0.0000e+00	2.1222e-04	1.3030e-04	-8.1919e-05	-3.8601e-01
236	1995	8	26	2	30	3.4000e+00	1.6000e-01	5.4590e+01	8.4700e+01	5.8000e-02	0.0000e+00	5.2246e-04	1.6200e-04	-3.6046e-04	-6.8993e-01
237	1995	8	26	3	0	2.7000e+00	2.7000e-01	4.5840e+01	8.3700e+01	1.7100e-01	0.0000e+00	6.7422e-04	8.9993e-05	-5.8423e-04	-8.6652e-01
238	1995	8	26	3	30	3.2000e+00	1.4000e-01	3.4830e+01	8.2800e+01	2.7700e-01	0.0000e+00	7.1649e-04	1.2345e-04	-5.9304e-04	-8.2770e-01
239	1995	8	26	4	0	2.8000e+00	5.1000e-01	9.2990e+01	8.2400e+01	2.0400e-01	7.5000e-01	9.4214e-04	9.2844e-05	-8.4930e-04	-9.0145e-01
240	1995	8	26	4	30	2.9000e+00	3.4000e-01	6.3020e+01	8.2800e+01	5.3000e-02	7.5000e-01	5.9879e-04	1.1305e-04	-4.8574e-04	-8.1121e-01
241	1995	8	26	5	0	2.8000e+00	1.4000e-01	6.4680e+01	8.2400e+01	3.2000e-02	7.5000e-01	8.9800e-05	1.1585e-04	2.6046e-05	2.9004e-01
242	1995	8	26	5	30	3.0000e+00	2.4000e-01	1.5344e+02	8.2200e+01	2.9200e-01	7.5000e-01	2.9281e-04	1.0978e-04	-1.8303e-04	-6.2507e-01
243	1995	8	26	6	0	3.1000e+00	4.5000e-01	1.8420e+01	8.1200e+01	2.3000e-01	7.5000e-01	2.6950e-05	1.0763e-04	8.0685e-05	2.9939e+00
244	1995	8	26	6	30	1.8000e+00	1.8000e-01	3.0130e+01	8.0600e+01	5.0000e-02	7.5000e-01	5.2100e-05	4.6977e-05	-5.1227e-06	-9.8324e-02
245	1995	8	26	7	0	2.3000e+00	1.7000e-01	1.2878e+02	7.9900e+01	5.1000e-02	7.5000e-01	1.4541e-04	8.1270e-05	-6.4140e-05	-4.4110e-01
246	1995	8	26	7	30	9.0000e-01	5.2000e-01	5.2473e+03	7.8700e+01	2.6000e-01	7.5000e-01	2.3107e-04	2.2635e-05	-2.0844e-04	-9.0204e-01
247	1995	8	26	8	0	2.2000e+00	9.5000e-01	1.9628e+02	7.9500e+01	4.4300e-01	3.1250e-01	4.1700e-04	5.1436e-05	-3.6556e-04	-8.7665e-01
248	1995	8	26	8	30	3.4000e+00	8.7000e-01	9.7590e+01	8.0400e+01	9.6000e-02	3.1250e-01	6.8266e-04	1.4811e-04	-5.3455e-04	-7.8304e-01
249	1995	8	26	9	0	3.2000e+00	2.4000e-01	8.4140e+01	7.9900e+01	6.8000e-02	0.0000e+00	1.2048e-04	1.4871e-04	2.8233e-05	2.3434e-01
250	1995	8	26	9	30	3.3000e+00	3.3000e-01	2.0010e+01	7.8900e+01	1.3000e-02	0.0000e+00	8.5370e-05	1.5603e-04	7.0658e-05	8.2767e-01
251	1995	8	28	0	30	4.4000e+00	4.8000e-01	2.1760e+01	8.7300e+01	1.2000e-02	0.0000e+00	1.5937e-04	2.4762e-04	8.8253e-05	5.5376e-01
252	1995	8	28	1	0	5.1000e+00	6.9000e-01	6.7620e+01	8.6900e+01	2.8000e-02	0.0000e+00	2.5394e-04	3.3837e-04	8.4428e-05	3.3247e-01
253	1995	8	28	1	30	3.9000e+00	6.0000e-01	3.5540e+01	8.6400e+01	2.7000e-02	0.0000e+00	3.4864e-04	1.9171e-04	-1.5693e-04	-4.5012e-01
254	1995	8	28	2	0	3.8000e+00	8.5000e-01	5.7680e+01	8.5900e+01	3.4000e-02	0.0000e+00	4.1941e-04	1.8028e-04	-2.3913e-04	-5.7017e-01
255	1995	8	28	2	30	3.7000e+00	2.4000e-01	2.3770e+01	8.5200e+01	4.6000e-02	0.0000e+00	2.9520e-04	1.8212e-04	-1.1308e-04	-3.8308e-01
256	1995	8	28	3	0	4.5000e+00	2.7000e-01	2.5890e+01	8.4600e+01	2.6000e-02	0.0000e+00	1.1411e-04	2.7898e-04	1.6487e-04	1.4448e+00
257	1995	8	28	3	30	3.8000e+00	4.7000e-01	2.7480e+01	8.3900e+01	1.3700e-01	0.0000e+00	9.7820e-05	1.7289e-04	7.5068e-05	7.6741e-01
258	1995	8	28	4	0	3.0000e+00	1.6000e-01	2.8790e+01	8.2900e+01	1.7000e-02	0.0000e+00	4.1958e-04	1.3100e-04	-2.8858e-04	-6.8778e-01
259	1995	8	28	4	30	4.5000e+00	7.5000e-01	4.8400e+00	8.2600e+01	1.9000e-02	0.0000e+00	5.0188e-04	2.5788e-04	-2.4400e-04	-4.8616e-01
260	1995	8	28	5	0	4.7000e+00	3.3000e-01	7.1400e+00	8.1700e+01	1.3600e-01	0.0000e+00	4.1960e-04	2.7608e-04	-1.4352e-04	-3.4205e-01
261	1995	8	28	5	30	4.5000e+00	4.0000e-01	3.5400e+00	8.0800e+01	8.5000e-02	0.0000e+00	2.7672e-04	2.5896e-04	-1.7764e-05	-6.4194e-02
262	1995	8	28	6	0	4.5000e+00	1.6000e-01	9.1000e+00	7.9900e+01	2.6000e-02	0.0000e+00	2.1919e-04	3.0002e-04	8.0829e-05	3.6876e-01
263	1995	8	28	6	30	3.9000e+00	4.9000e-01	2.8750e+01	7.9700e+01	3.6000e-02	0.0000e+00	4.0456e-04	2.0823e-04	-1.9633e-04	-4.8528e-01
264	1995	8	28	10	0	3.7000e+00	8.0000e-02	8.0300e+00	7.6300e+01	2.7000e-02	0.0000e+00	8.2110e-05	2.1765e-04	1.3554e-04	1.6507e+00

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DpIx	Year	Mon	Day	Hour	Min	Wind_Speed	Wnd_Spd_Var	Wnd_Dir_Var	Temperature	Temp_Var	Cloud_Cover	Data_EDR	Model_EDR	EDR_Err_MmD	EDR_Err_Nrm
265	1995	8	28	10	30	3.6000e+00	1.8000e-01	6.4300e+00	7.5900e+01	2.8000e-02	0.0000e+00	5.7970e-05	1.9312e-04	1.3515e-04	2.3314e+00
266	1995	8	29	1	0	5.2000e+00	3.7000e-01	3.0340e+01	8.8100e+01	2.8000e-02	0.0000e+00	5.0823e-04	3.5227e-04	-1.5596e-04	-3.0687e-01
267	1995	8	29	1	30	4.0000e+00	2.8000e-01	1.2600e+01	8.7100e+01	1.5400e-01	0.0000e+00	1.6965e-04	1.8526e-04	1.5612e-05	9.2023e-02
268	1995	8	29	2	0	3.8000e+00	2.5000e-01	8.3500e+00	8.5900e+01	8.0000e-02	0.0000e+00	8.2920e-05	1.8016e-04	9.7235e-05	1.1726e+00
269	1995	8	29	2	30	2.7000e+00	4.4000e-01	1.1608e+02	8.4900e+01	2.1000e-01	0.0000e+00	1.3466e-04	8.6755e-05	-4.7905e-05	-3.5575e-01
270	1995	8	29	3	0	2.0000e+00	1.3000e-01	2.4403e+02	8.4200e+01	8.7000e-02	0.0000e+00	1.2495e-04	6.2267e-05	-6.2683e-05	-5.0166e-01
271	1995	8	29	3	30	2.5000e+00	3.0000e-01	5.9780e+01	8.3400e+01	1.4200e-01	0.0000e+00	1.7456e-04	7.9564e-05	-9.4996e-05	-5.4420e-01
272	1995	8	29	4	0	2.9000e+00	5.1000e-01	6.5840e+01	8.2700e+01	2.3800e-01	0.0000e+00	3.0527e-04	9.6732e-05	-2.0854e-04	-6.8313e-01
273	1995	8	29	4	30	3.4000e+00	3.4000e-01	2.0192e+02	8.2900e+01	2.0900e-01	0.0000e+00	8.7978e-04	1.5002e-04	-7.2976e-04	-8.2948e-01
274	1995	8	29	5	0	3.5000e+00	3.6000e-01	1.2705e+02	8.2300e+01	1.6700e-01	0.0000e+00	3.1365e-04	1.5920e-04	-1.5445e-04	-4.9241e-01
275	1995	8	29	5	30	2.9000e+00	6.0000e-01	1.8450e+01	8.2000e+01	5.0000e-02	0.0000e+00	2.1188e-04	1.0683e-04	-1.0505e-04	-4.9580e-01
276	1995	8	29	6	0	3.4000e+00	4.3000e-01	7.0490e+01	8.1400e+01	2.2000e-01	0.0000e+00	2.3261e-04	1.3929e-04	-9.3322e-05	-4.0119e-01
277	1995	8	29	6	30	2.8000e+00	5.3000e-01	1.9890e+01	8.0400e+01	7.8000e-02	0.0000e+00	2.6183e-04	1.0009e-04	-1.6174e-04	-6.1772e-01
278	1995	8	29	7	0	2.8000e+00	3.4000e-01	3.7270e+01	7.9800e+01	2.1000e-02	0.0000e+00	3.3668e-04	1.1200e-04	-2.2468e-04	-6.6734e-01
279	1995	8	29	7	30	3.1000e+00	1.0700e+00	3.8830e+01	7.9700e+01	7.4000e-02	0.0000e+00	5.0159e-04	1.1988e-04	-3.8171e-04	-7.6100e-01
280	1995	8	29	8	0	4.7000e+00	8.3000e-01	3.8600e+01	7.9600e+01	1.1800e-01	0.0000e+00	1.1767e-03	2.7778e-04	-8.9887e-04	-7.6392e-01
281	1995	8	29	8	30	4.8000e+00	8.1000e-01	2.1710e+01	7.9500e+01	7.2000e-02	0.0000e+00	2.6119e-03	2.9722e-04	-2.3147e-03	-8.8620e-01
282	1995	8	29	10	0	4.0000e+00	4.8000e-01	2.8600e+01	7.8000e+01	2.1000e-02	0.0000e+00	1.9576e-03	2.2691e-04	-1.7307e-03	-8.8409e-01
283	1995	8	29	10	30	3.7000e+00	5.9000e-01	3.2620e+01	7.7800e+01	1.5000e-02	0.0000e+00	2.1358e-03	1.9262e-04	-1.9432e-03	-9.0981e-01

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9. Hastie, T.; Tibshirani, R.; and Friedman, J.: *The Elements of Statistical Learning, Data Mining, Inference, and Prediction.* Springer-Verlag, 2002, ISBN 0-387-95284-5.

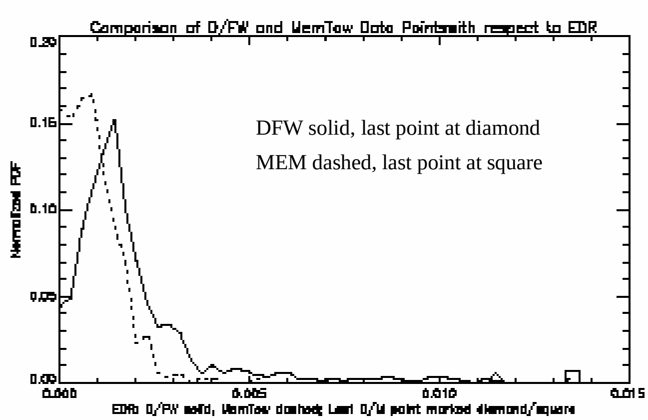


Figure 1. Day DFW/MEM data EDR distrib.

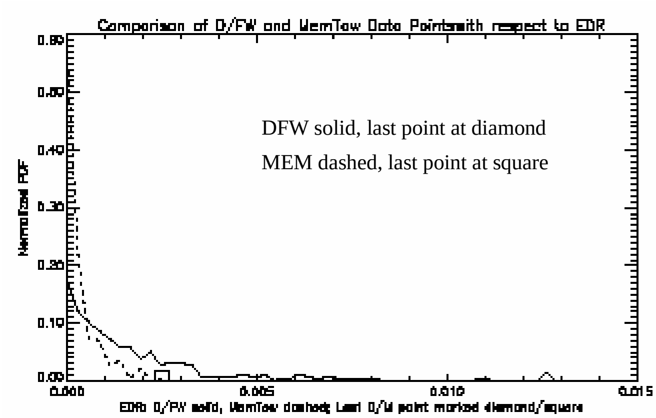


Figure 2. Night DFW/MEM data EDR distrib.

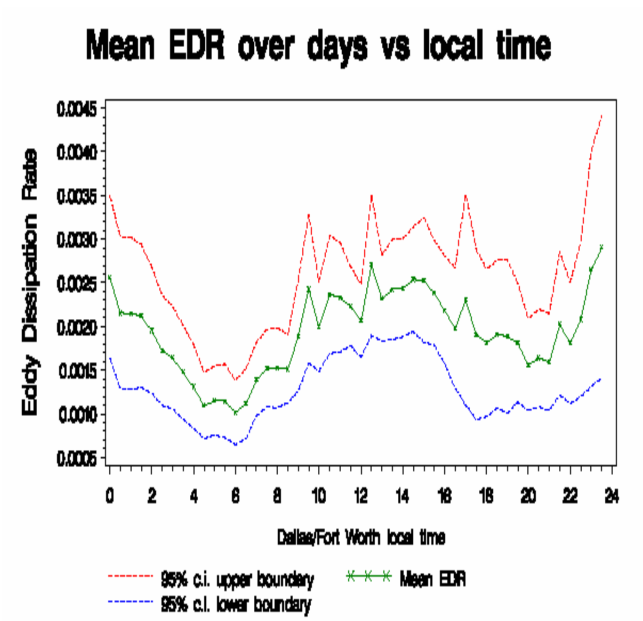


Figure 3. DFW EDR mean vs local time over days.

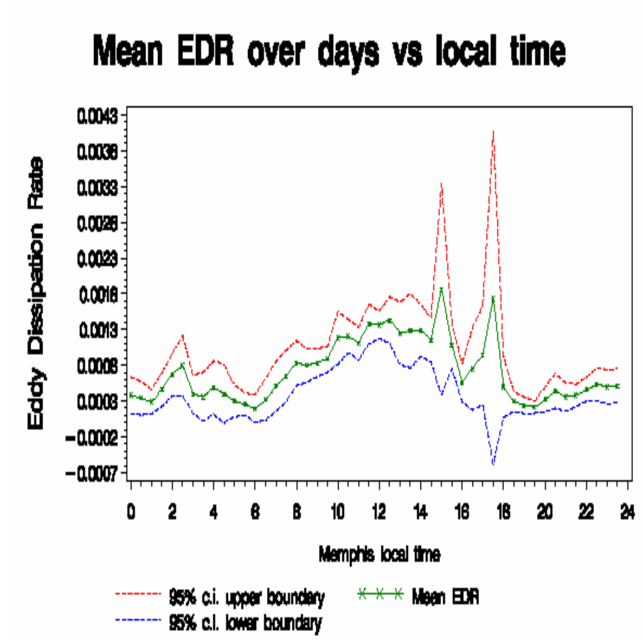


Figure 4. MEM EDR mean vs local time over days.

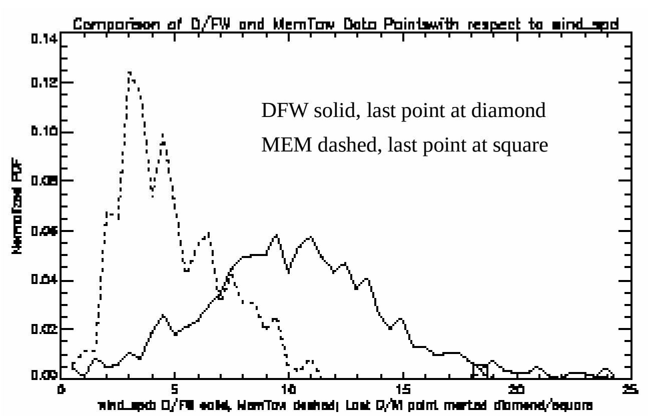


Figure 5. Day DFW/MEM data wind_spd distrib.

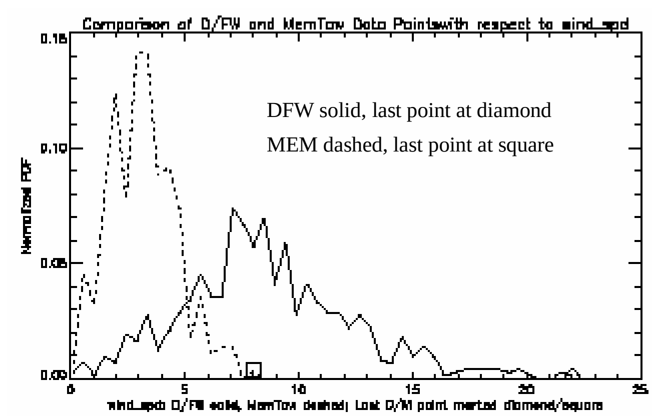


Figure 6. Night DFW/MEM data wind_spd distrib.

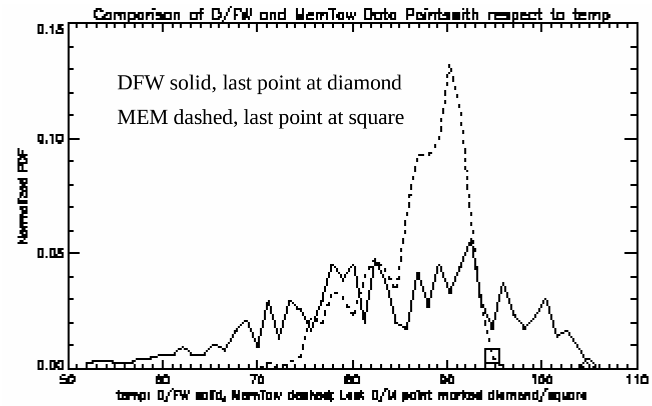


Figure 7. Day DFW/MEM data temp distrib .

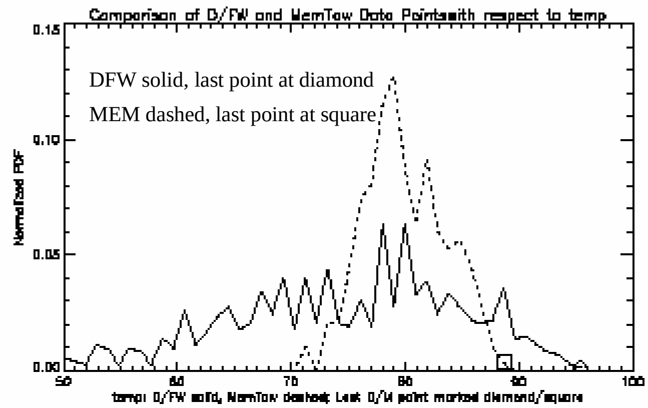


Figure 8. Night DFW/MEM data temp distrib.

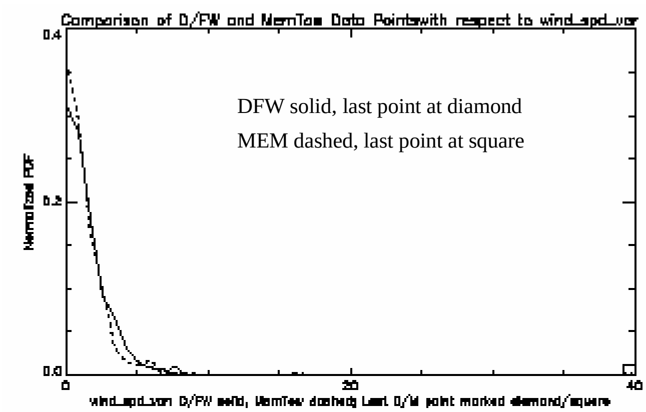


Figure 9. Day DFW/MEM data wind_spd_var distrib.

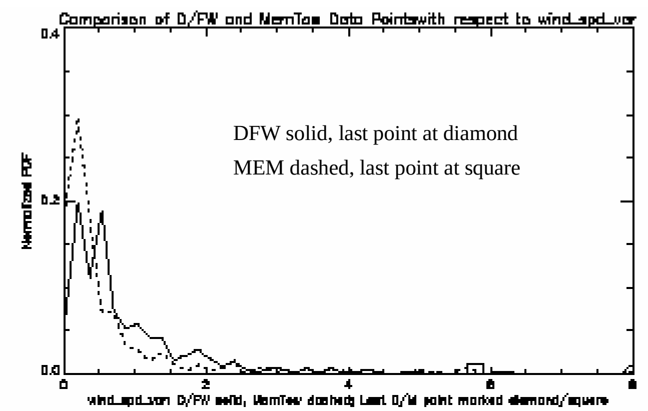


Figure 10. Night DFW/MEM data wind_spd_var distrib.

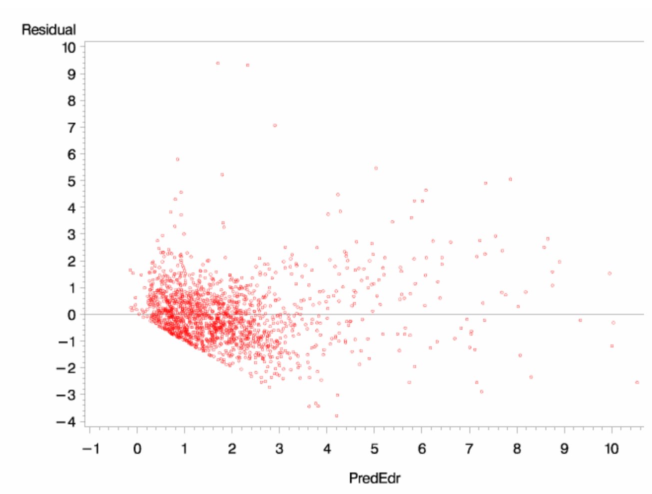


Figure 11. Sample EDR based residual distrib.

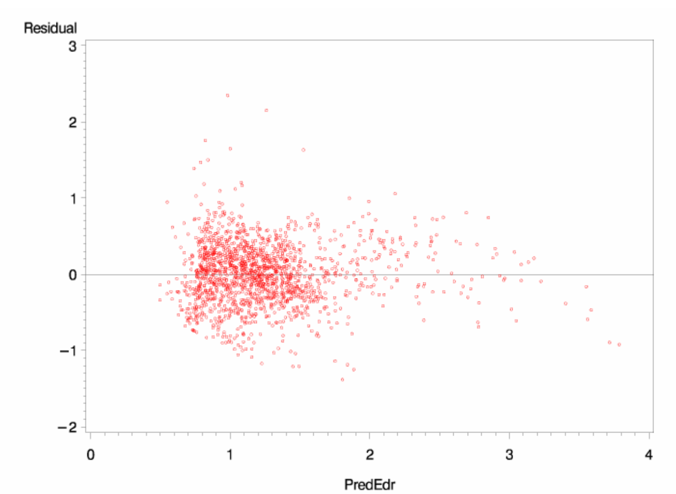


Figure 12. Sample ln(EDR) based residual distrib.

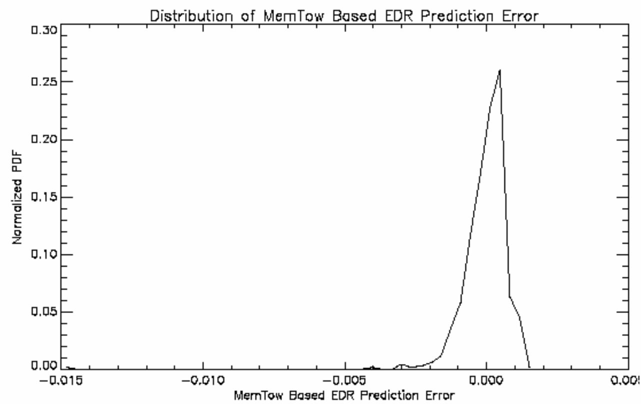


Figure 13. PE distrib. for M_u[DFW:all] on MEM.

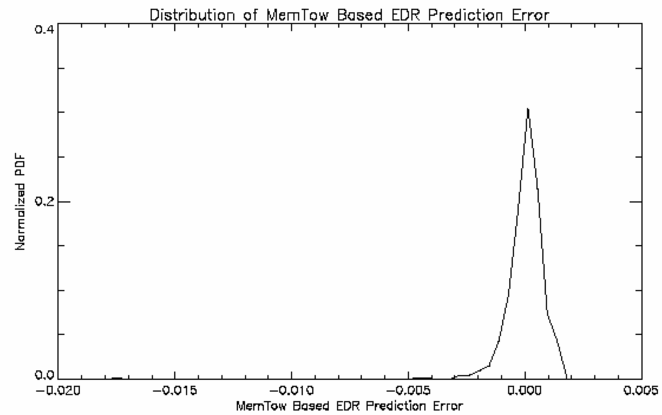


Figure 14. PE distrib. for M_{wsv}[DFW:all] on MEM.

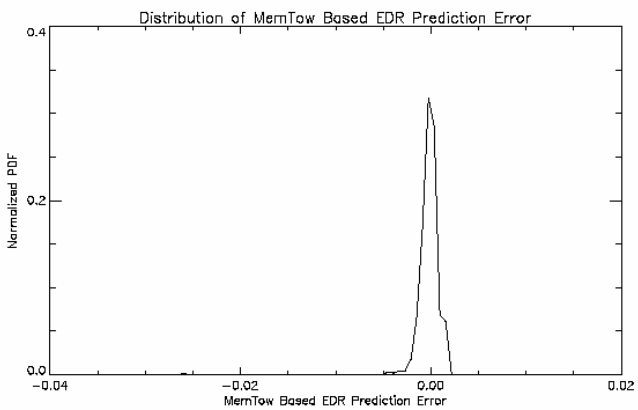


Figure 15. PE distrib. for M_{ws}[DFW:all] on MEM.

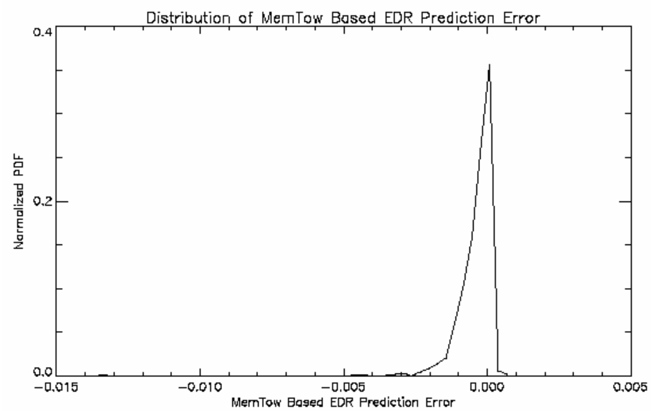


Figure 16. PE distrib. for lnM_{wsv}[DFW:all] on MEM.

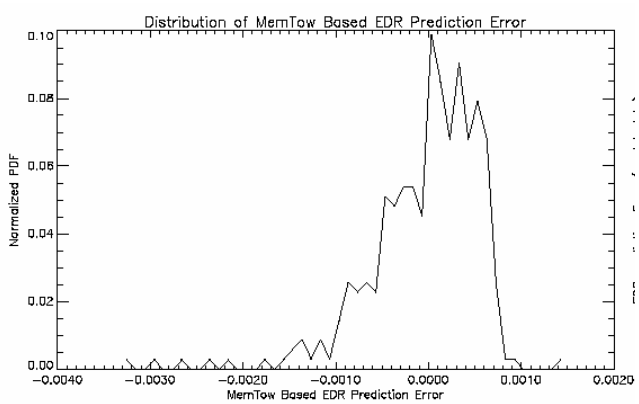


Figure 17. PE distrib. for M_u[DFW_d:all] on MEM_d.

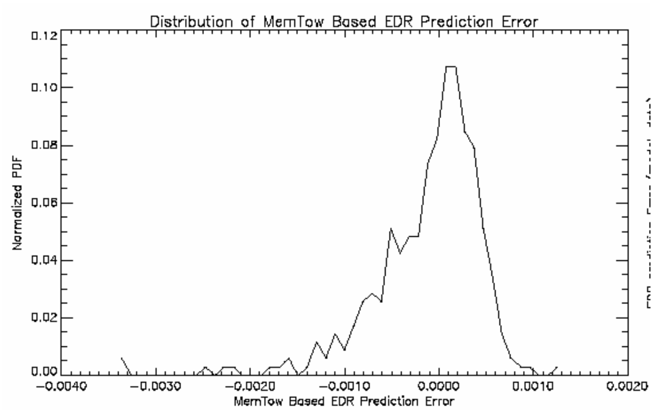


Figure 18. PE distrib. for M_{wsv}[DFW_d:all] on MEM_d.

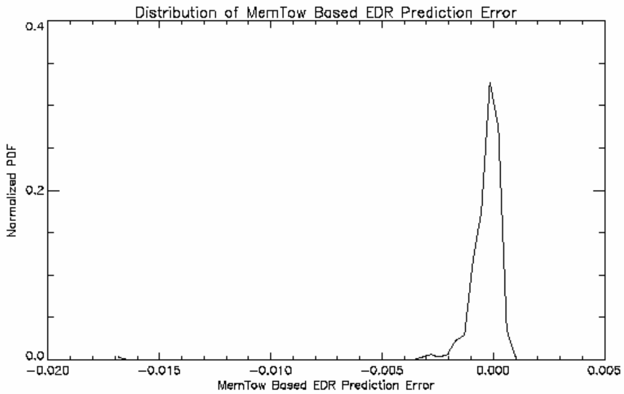


Figure 19. PE distrib. for M_{ws}[DFW_d:all] on MEM_d.

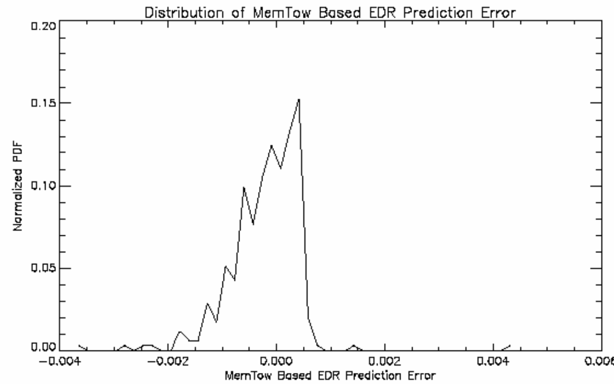


Figure 20. PE distrib. for $\ln M_{wsv}$[DFW_d:all] on MEM_d.

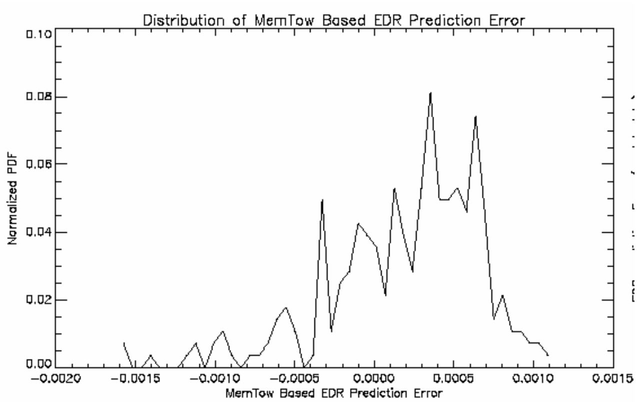


Figure 21. PE distrib. for M_u[DFW_n:all] on MEM_n.

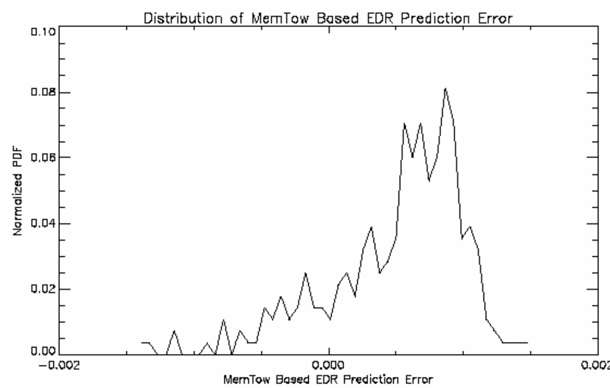


Figure 22. PE distrib. for M_{wsv}[DFW_n:all] on MEM_n.

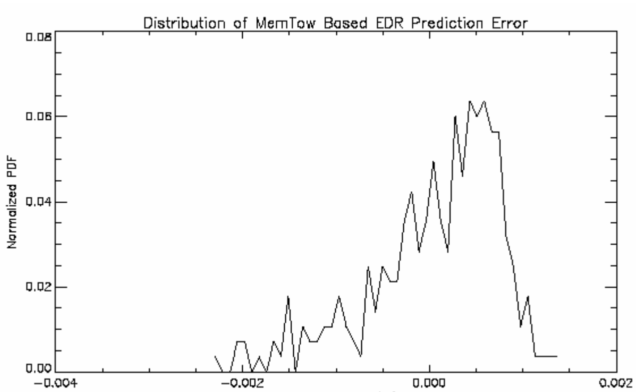


Figure 23. PE distrib. for M_{ws}[DFW_n:all] on MEM_n.

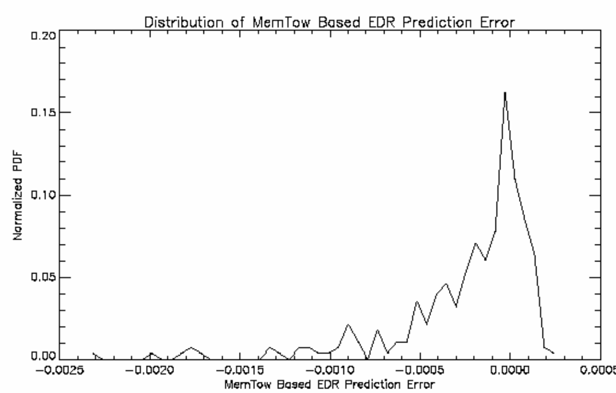


Figure 24. PE distrib. for $\ln M_{wsv}$[DFW_n:all] on MEM_n.

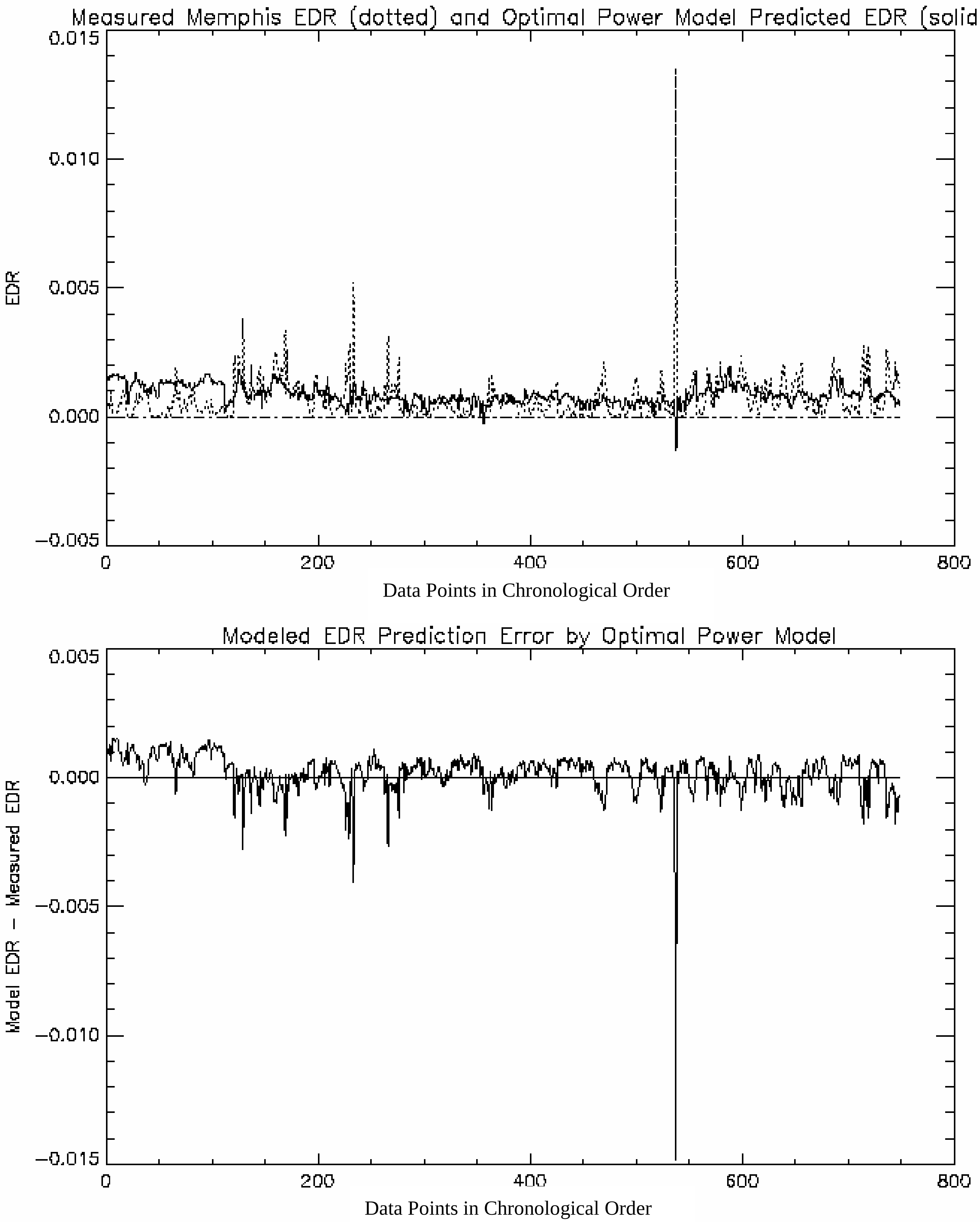


Figure 25. EDR˜ vs EDR and PE plots for M_u[DFW:all] on MEM.

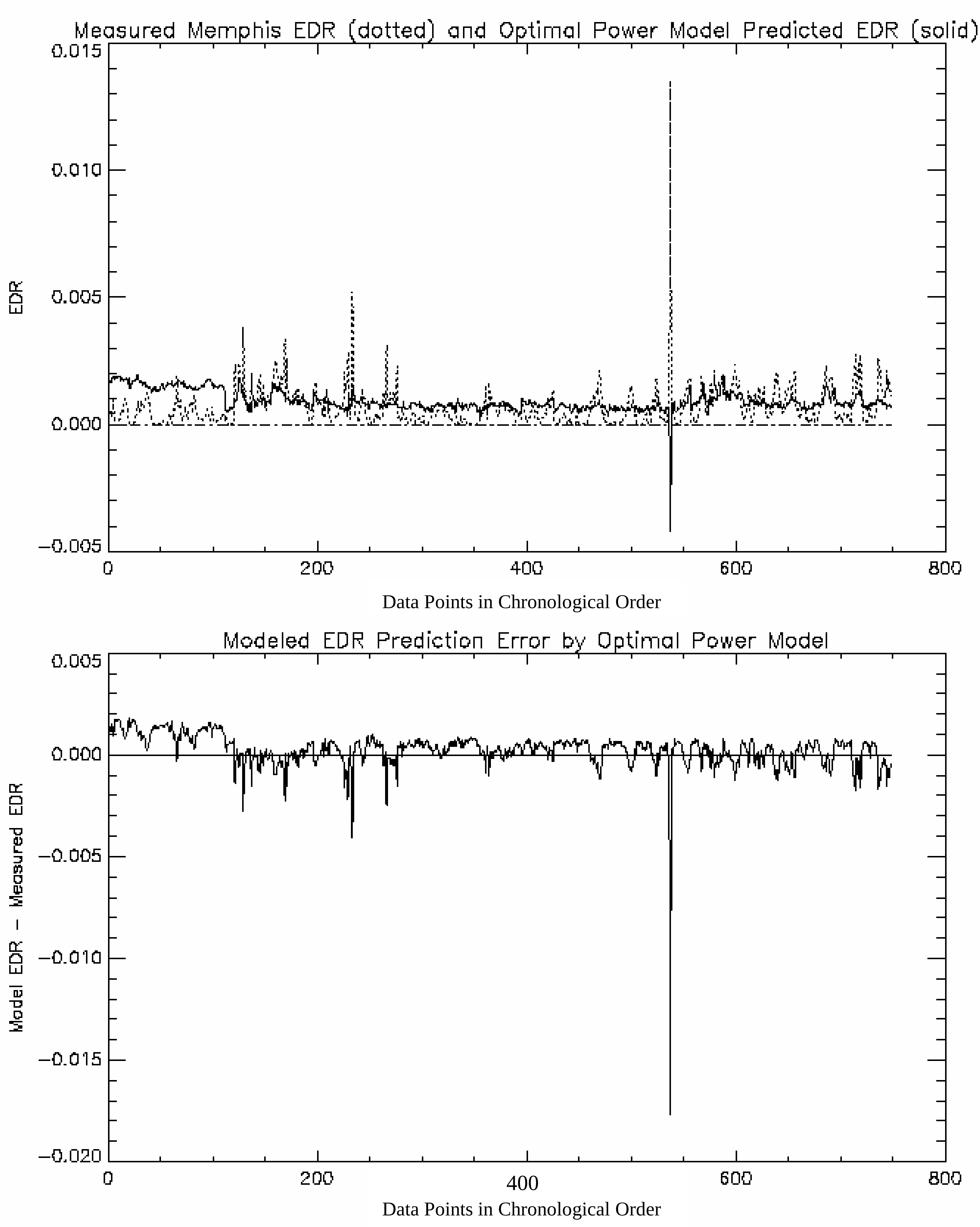


Figure 26. EDR˜ vs EDR and PE plots for M_{wsv}[DFW:all] on MEM.

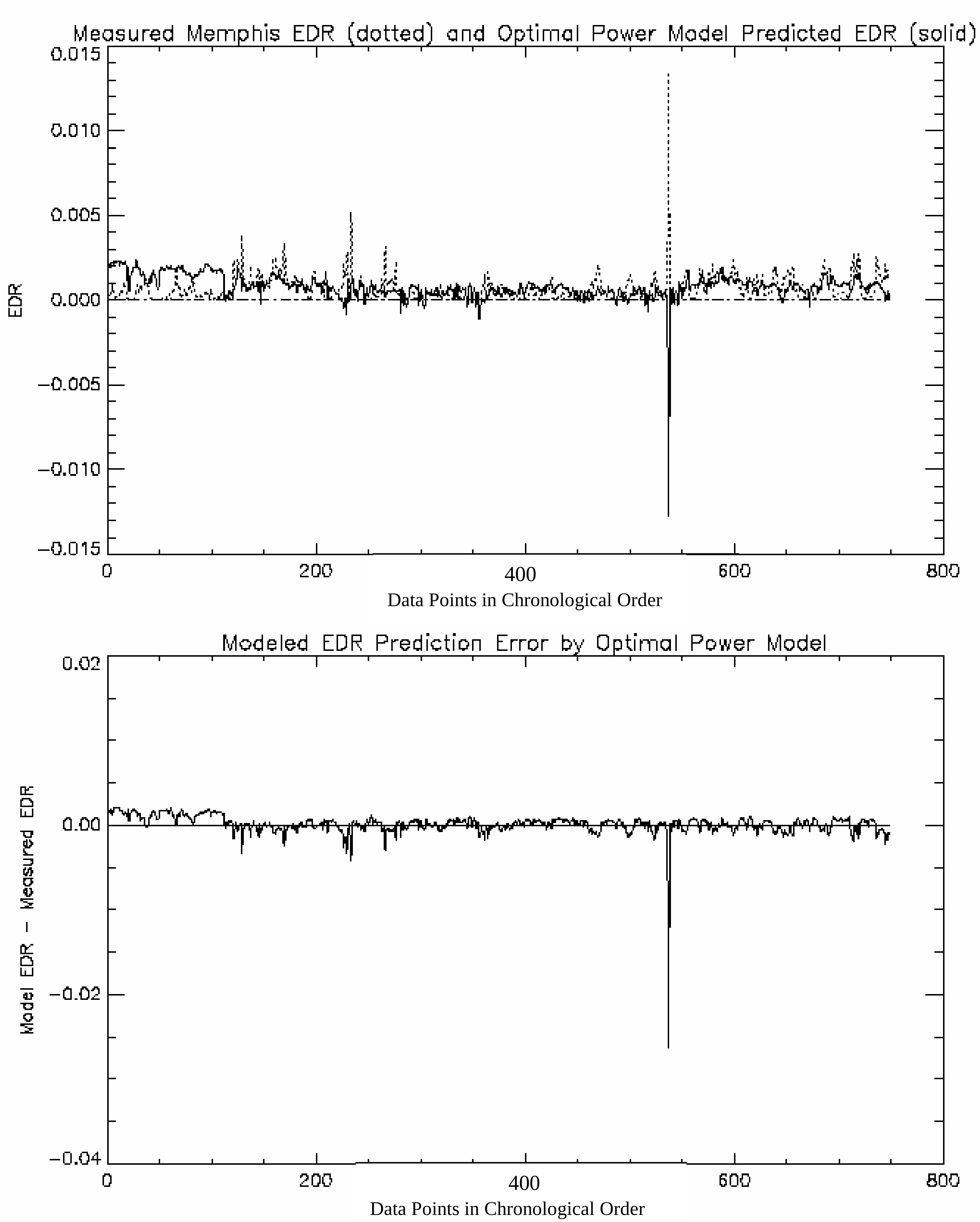


Figure 27. EDR˜ vs EDR and PE plots for M_{ws}[DFW:all] on MEM.

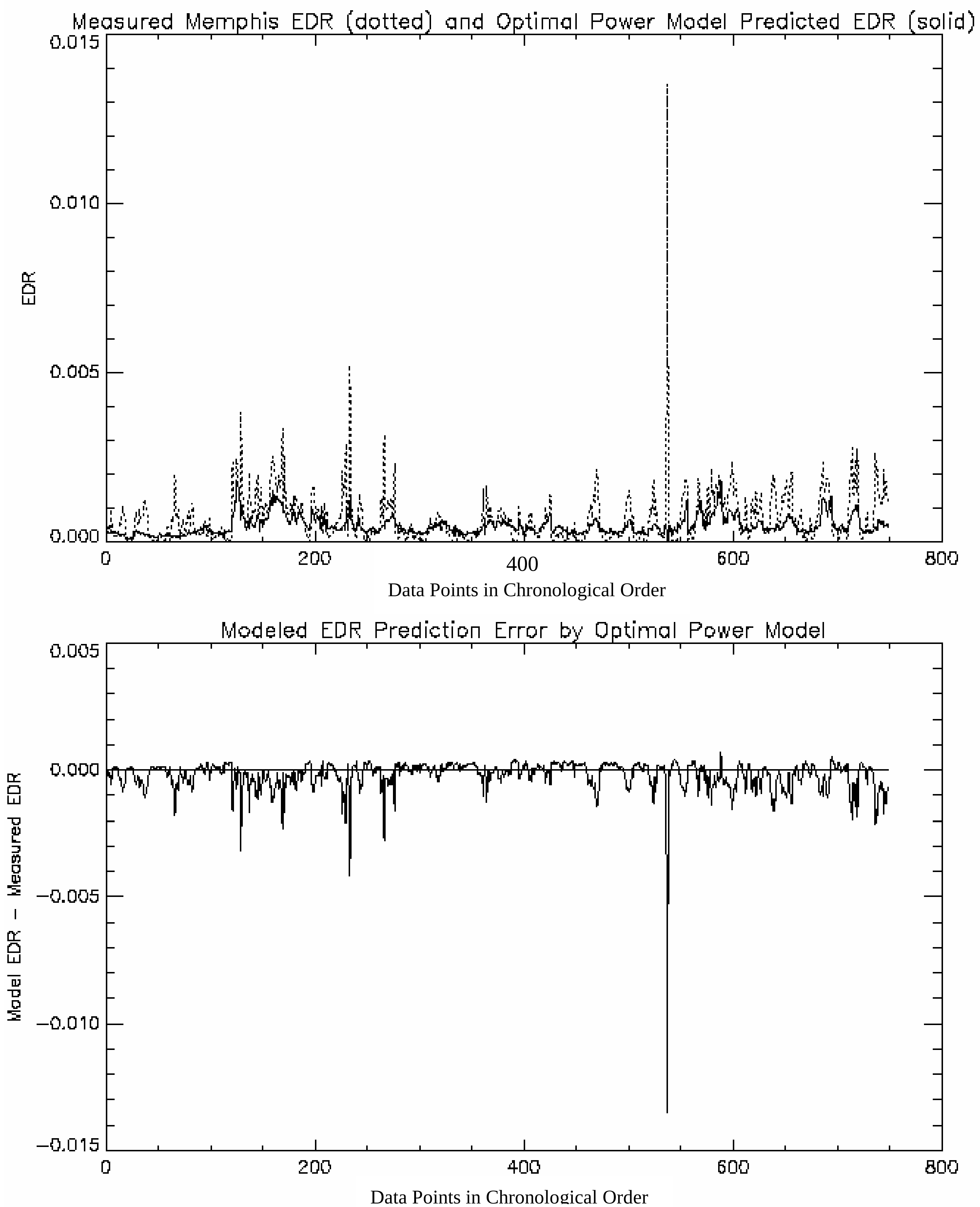


Figure 28. EDR˜ vs EDR and PE plots for $\ln M_{wsv}$[DFW:all] on MEM.

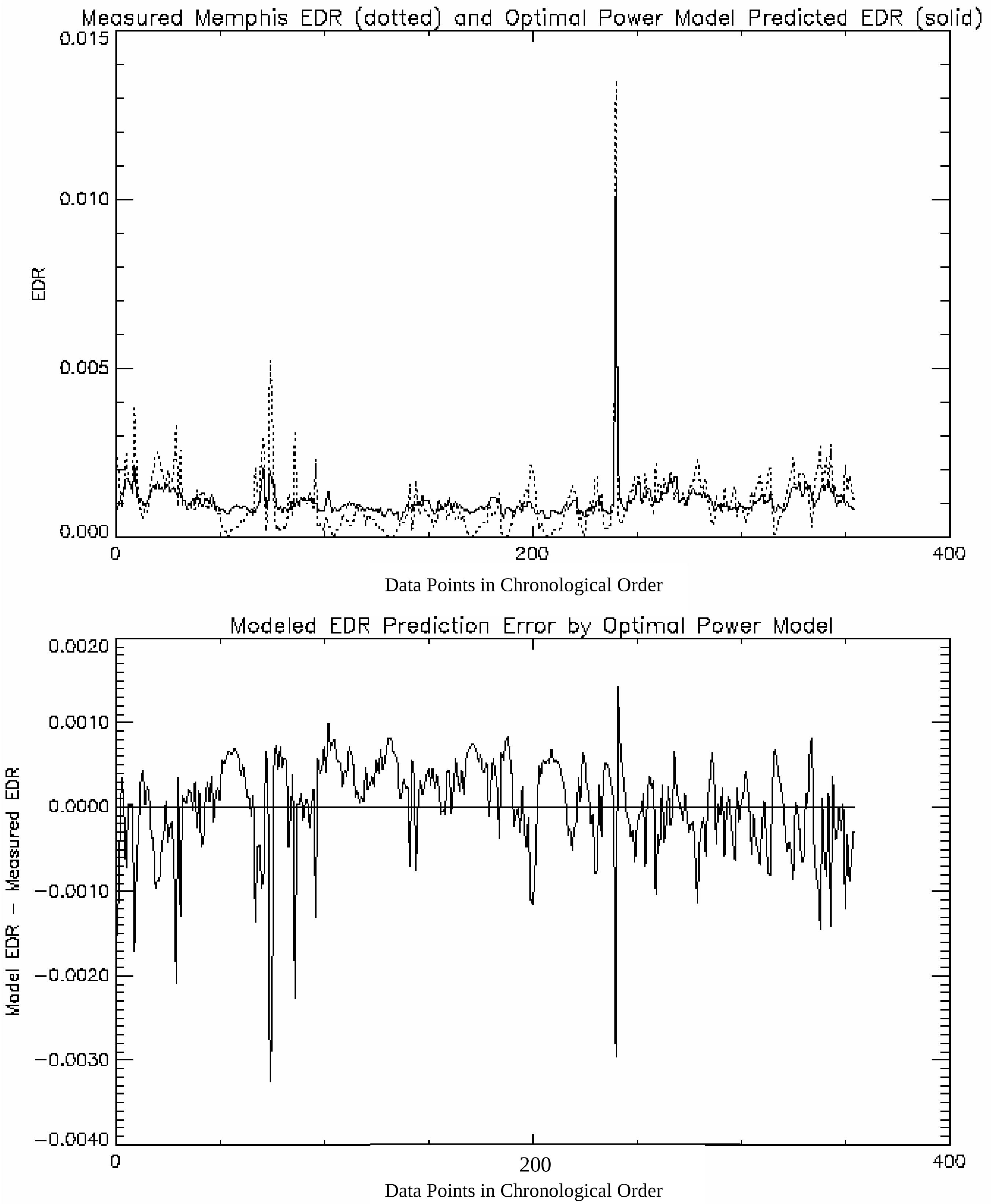
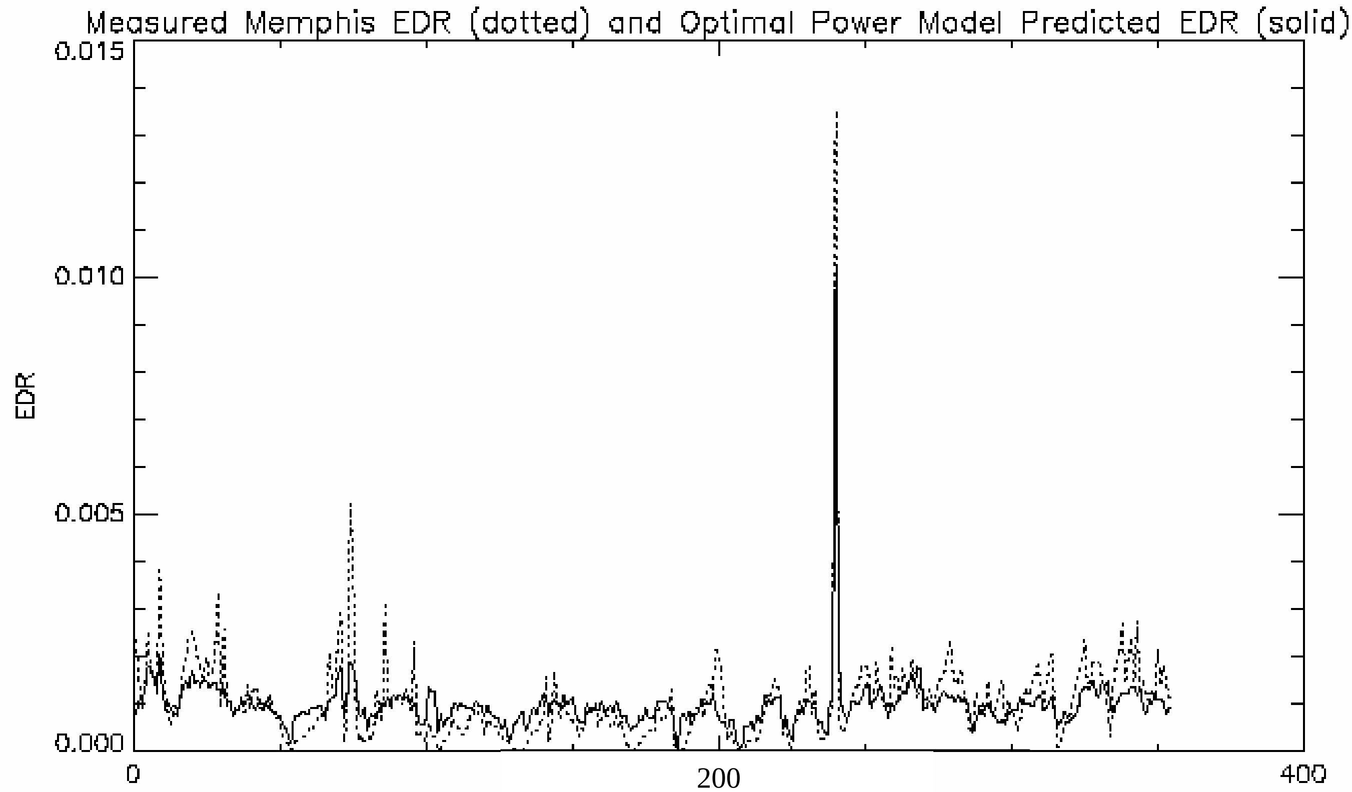
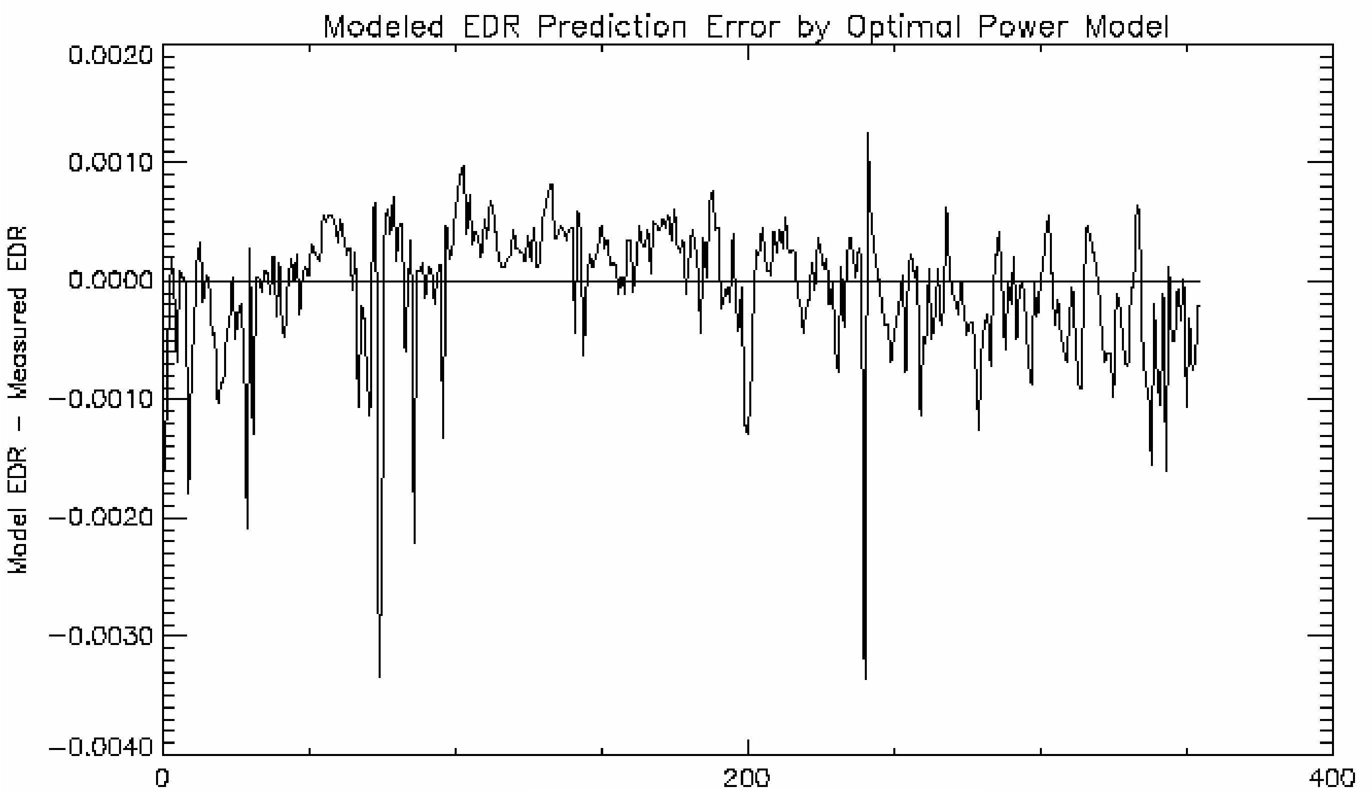


Figure 29. EDR˜ vs EDR and PE plots for $M_u[DFW_d:all]$ on MEM_d.



Data Points in Chronological Order



Data Points in Chronological Order

Figure 30. EDR˜ vs EDR and PE plots for M_{wsv}[DFW_d:all] on MEM_d.

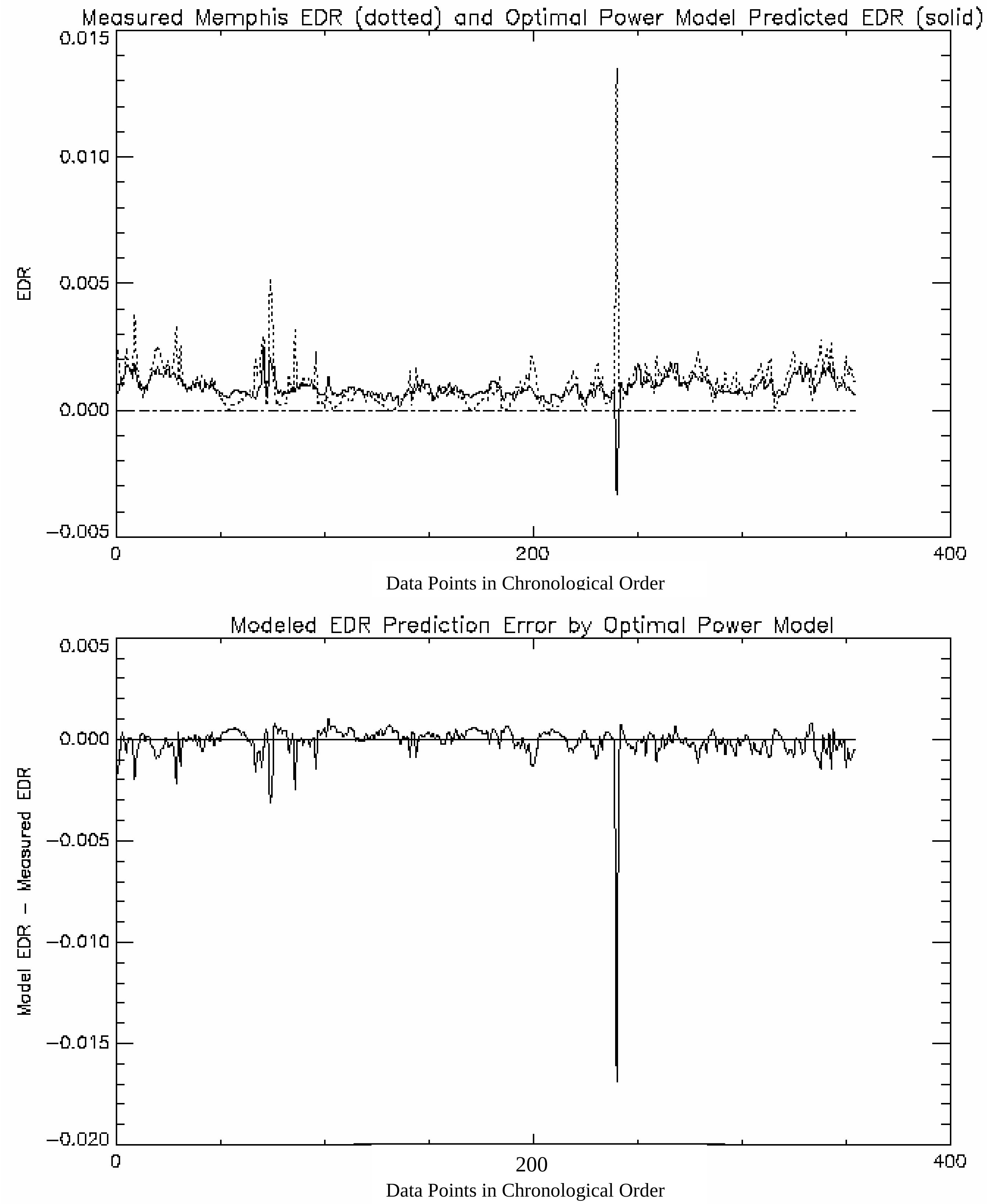


Figure 31. EDR˜ vs EDR and PE plots for M_{ws}[DFW$_d$:all] on MEM$_d$.

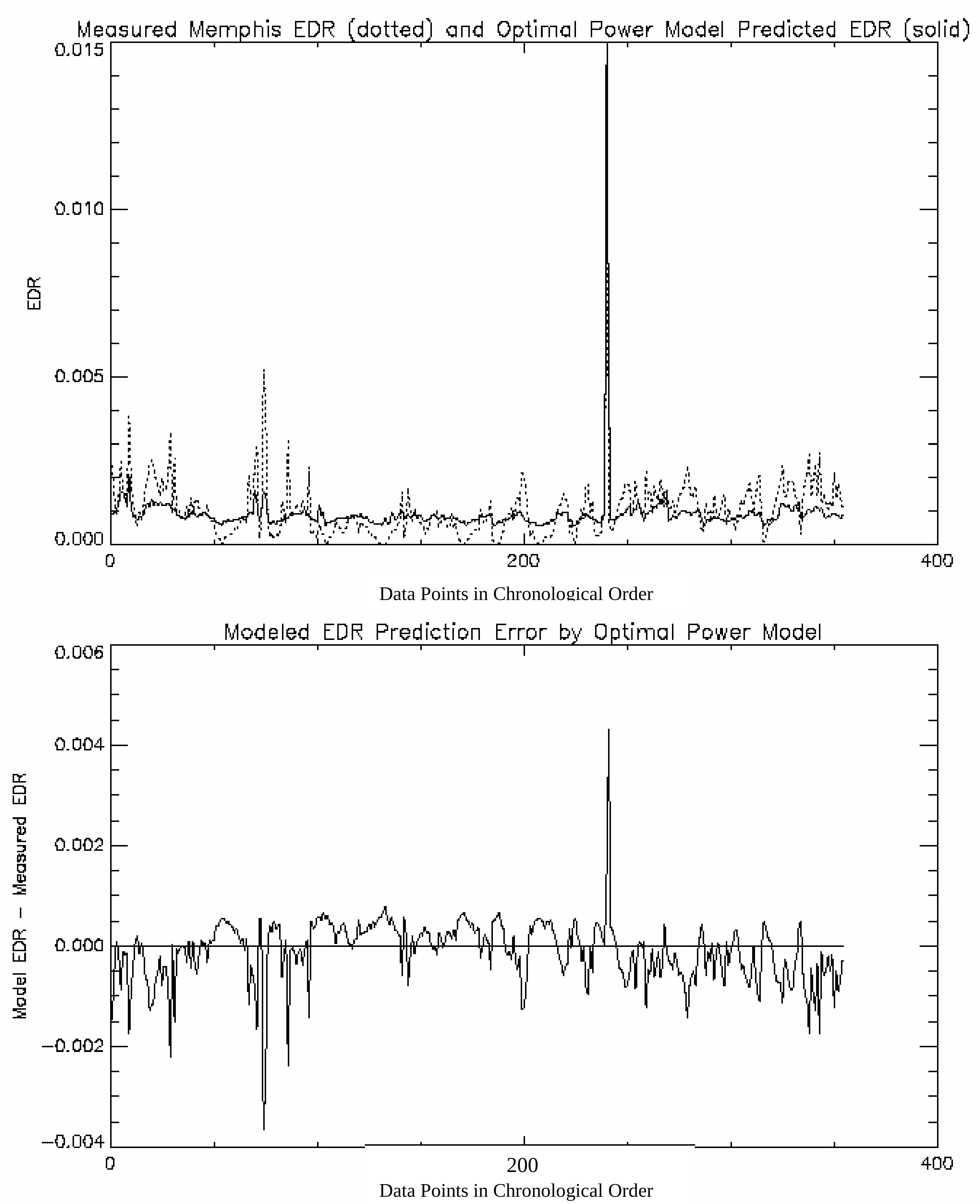


Figure 32. $\tilde{EDR}$ vs EDR and PE plots for $\ln M_{wsv}[DFW_d\text{:all}]$ on MEM_d.

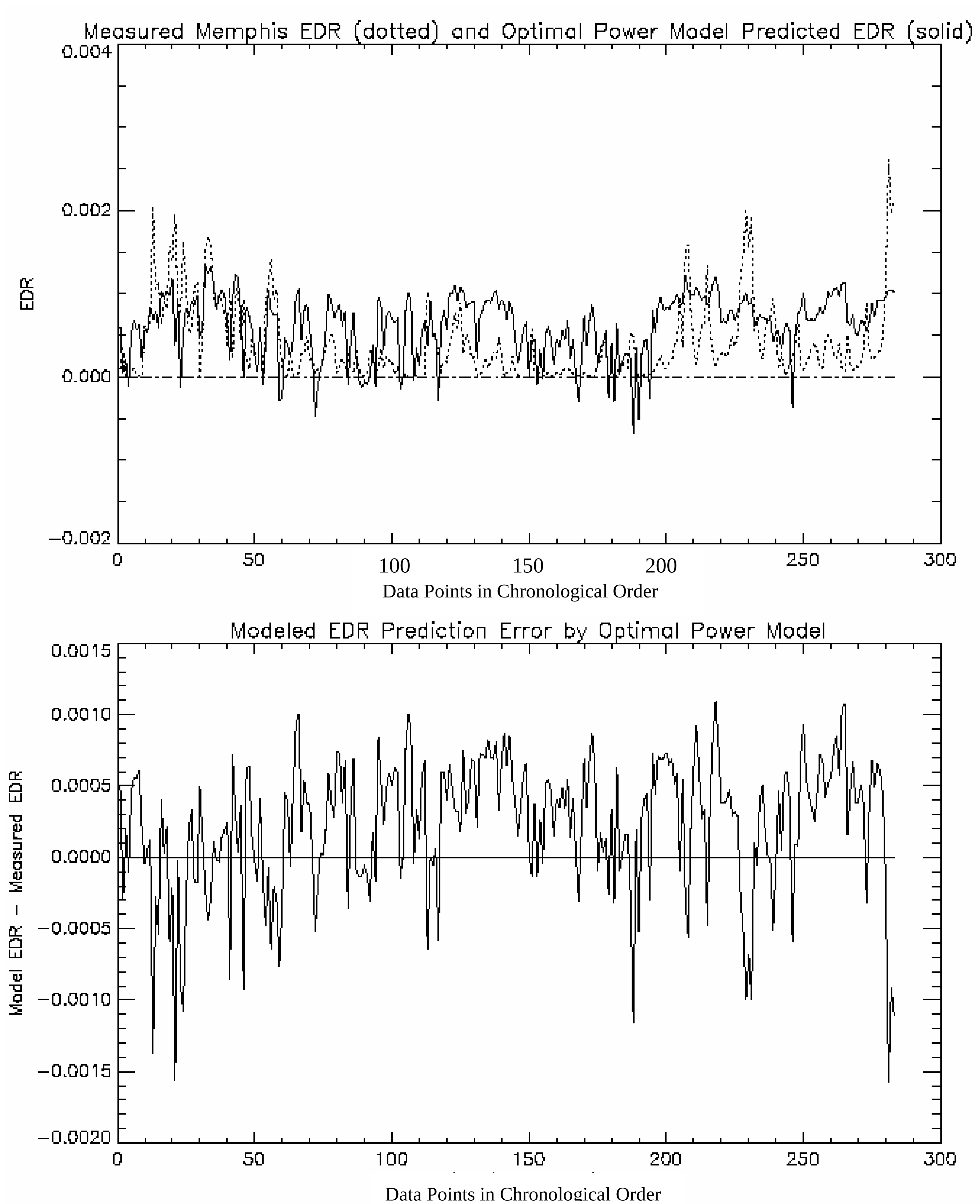


Figure 33. EDR˜ vs EDR and PE plots for $M_u[DFW_n{:}all]$ on MEM_n.

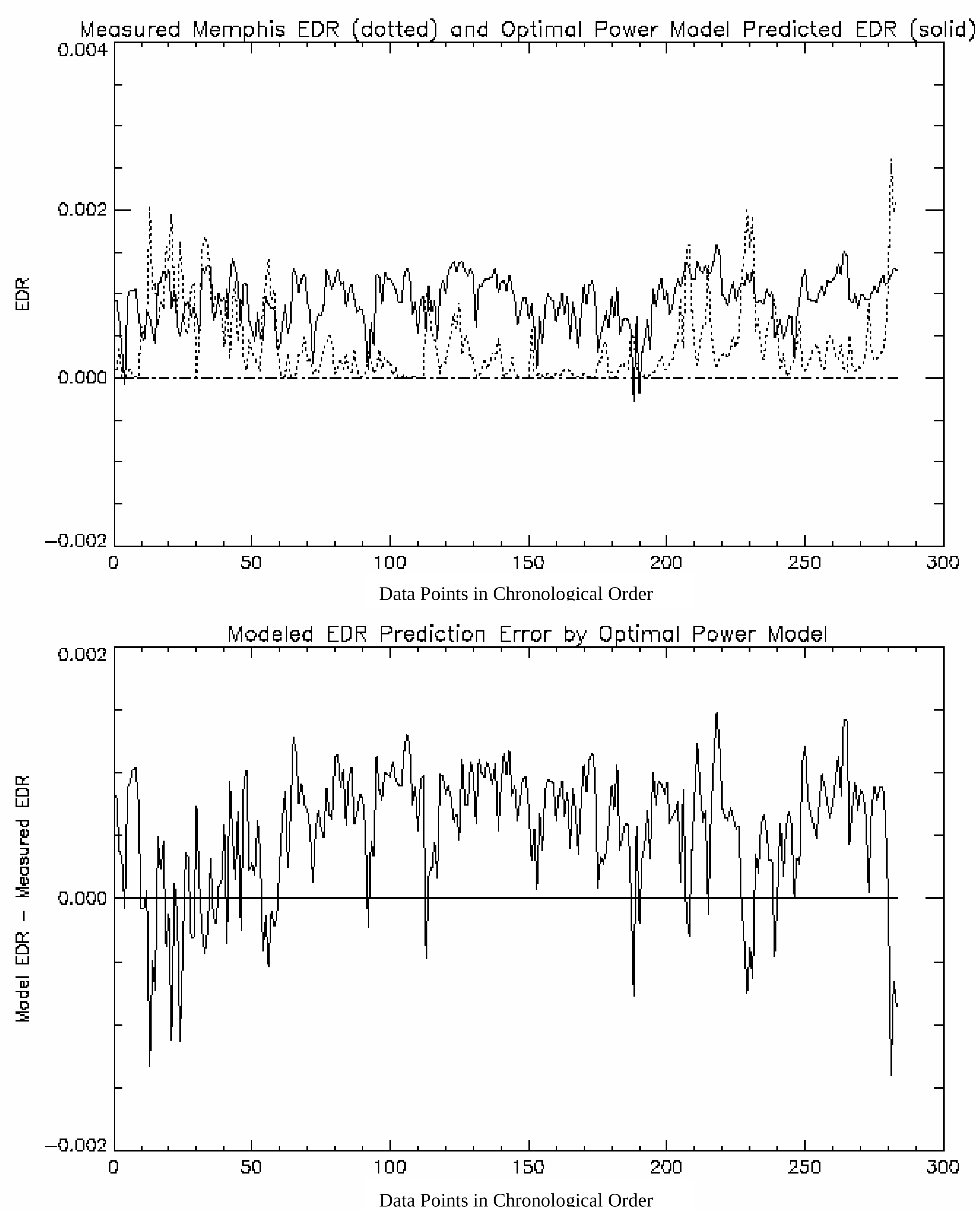
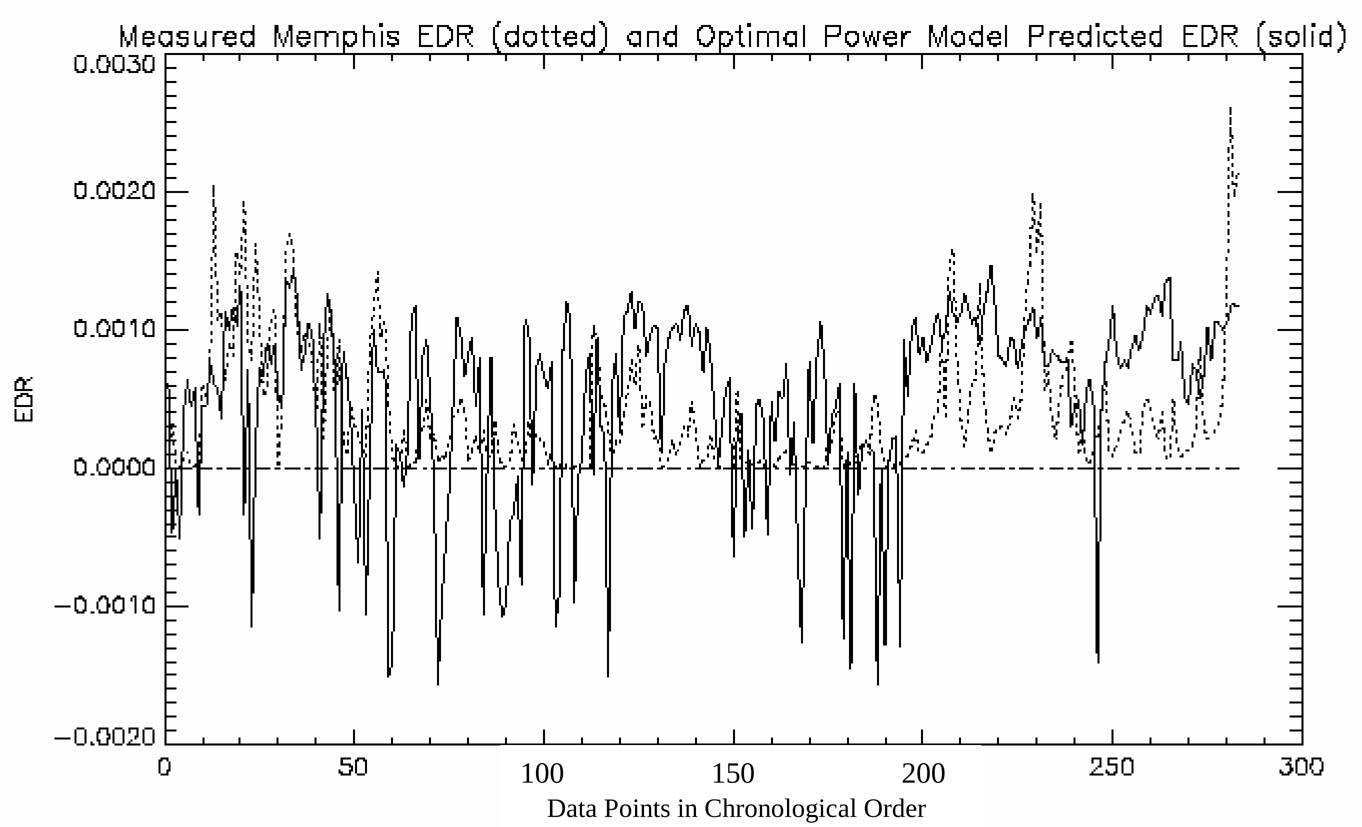


Figure 34. EDR$^{\sim}$ vs EDR and PE plots for $M_{wsv}[DFW_n{:}all]$ on MEM_n.



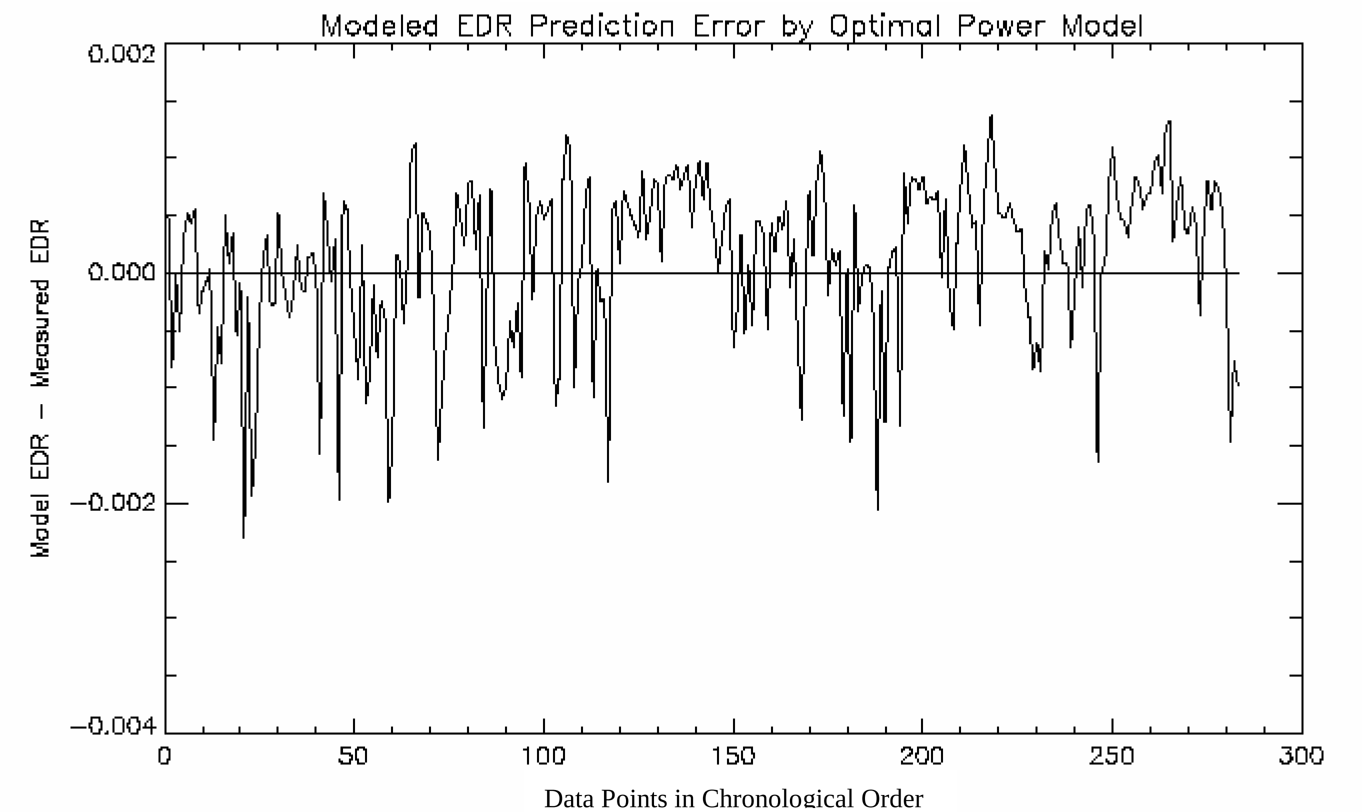


Figure 35. EDR˜ vs EDR and PE plots for M_{ws}[DFW_n:all] on MEM_n.

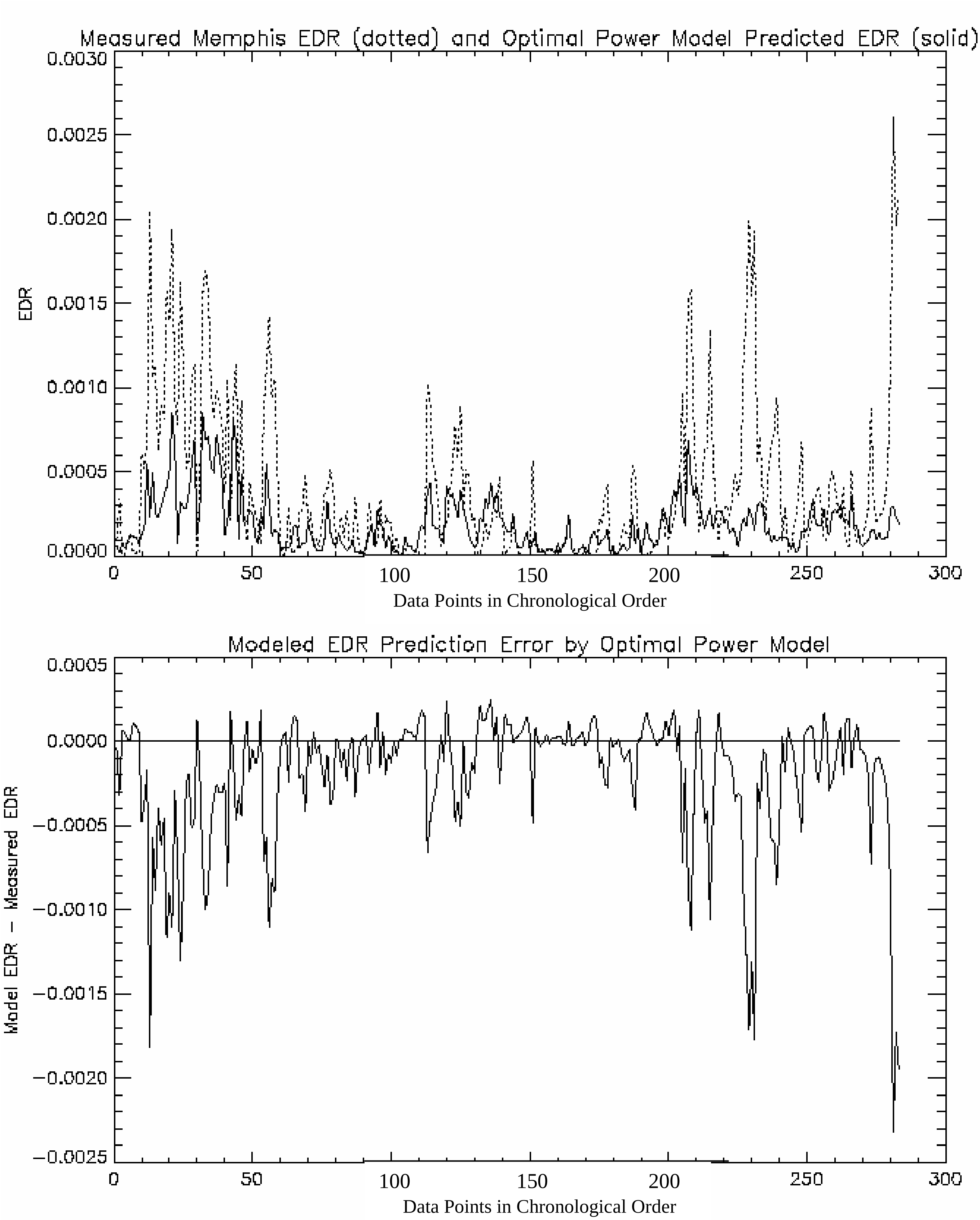
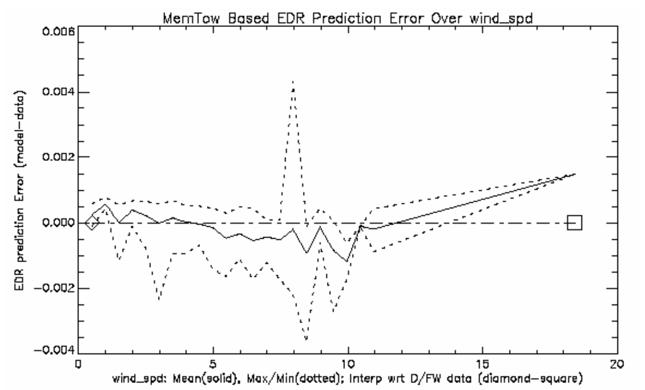


Figure 36. $EDR^{\sim}$ vs EDR and PE plots for $\ln M_{wsv}[DFW_n:all]$ on MEM_n.



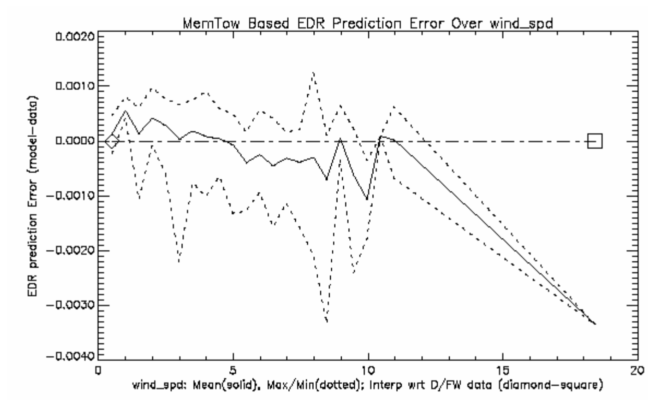
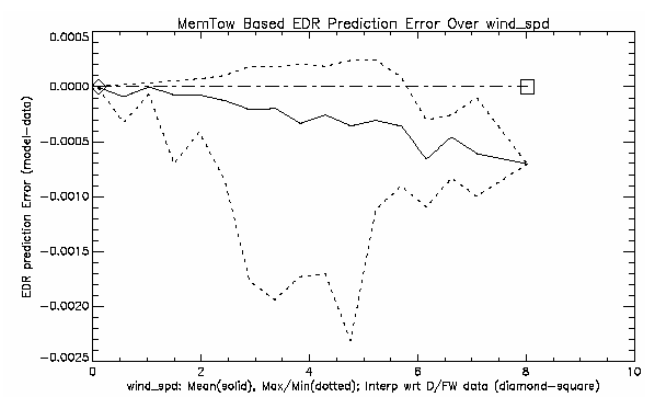


Figure 37. PE distrib. vs wind_spd for $\ln M_{wsv}[DFW_d:all]$. Figure 38. PE distrib. vs wind_spd for $M_{wsv}[DFW_d:all]$.
(mean solid, max/min dotted, diamond/square represent limits of DFW data variable range)



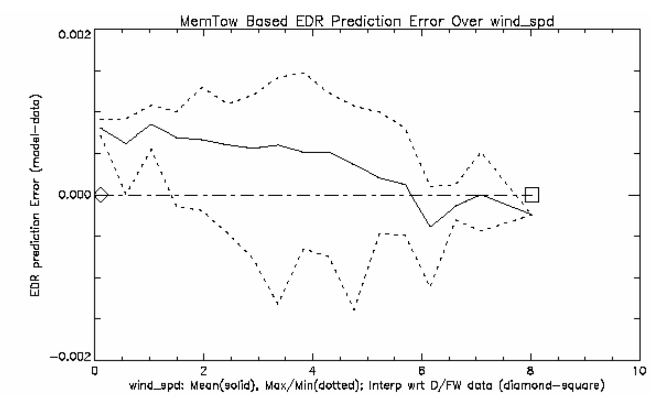


Figure 39. PE distrib. vs wind_spd for $\ln M_{wsv}[DFW_n:all]$ Figure 40. PE distrib. vs wind_spd for $M_{wsv}[DFW_n:all]$
(mean solid, max/min dotted, diamond/square represent limits of DFW data variable range)

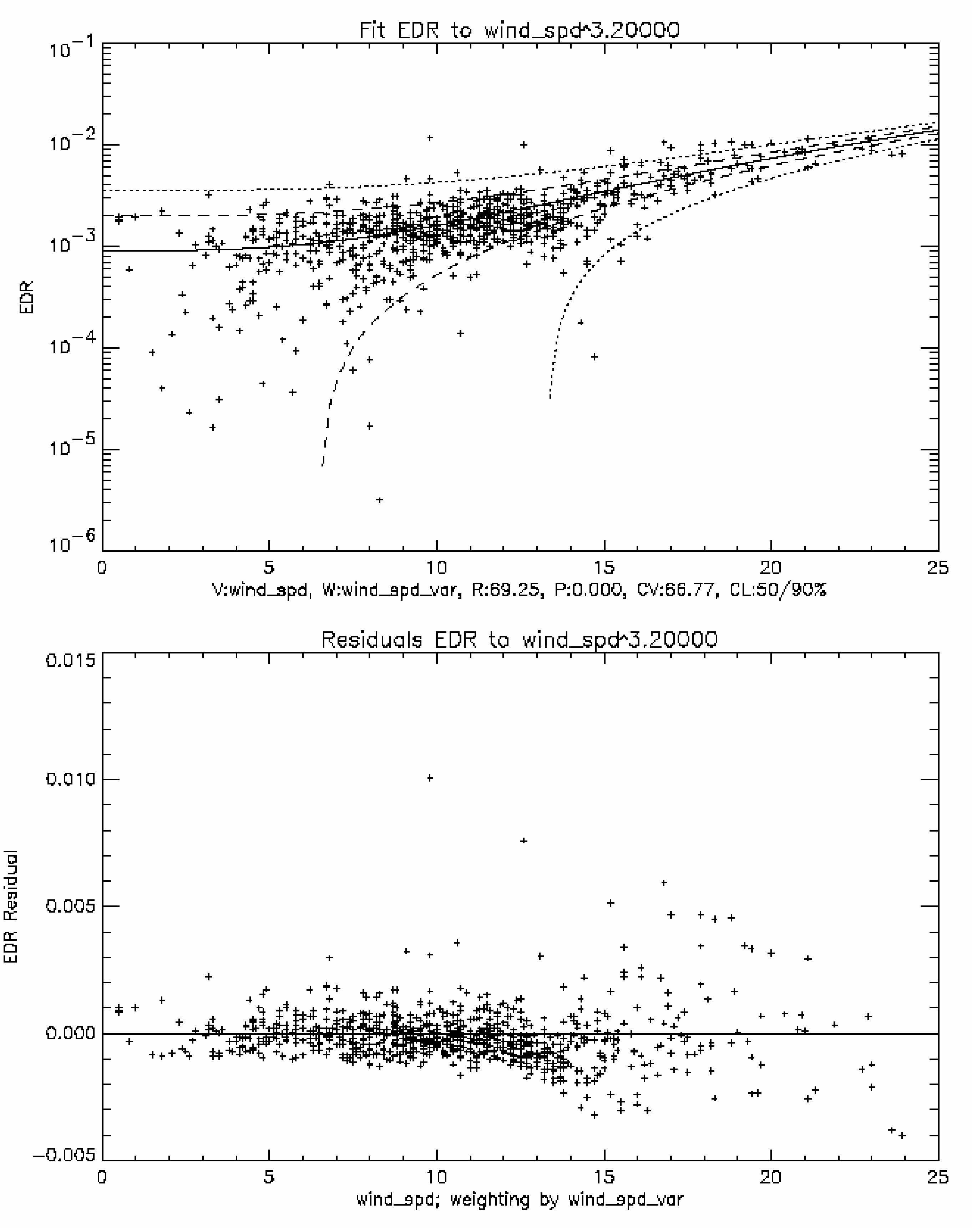


Figure 41. Opt power wind_spd regression and residual for day model.

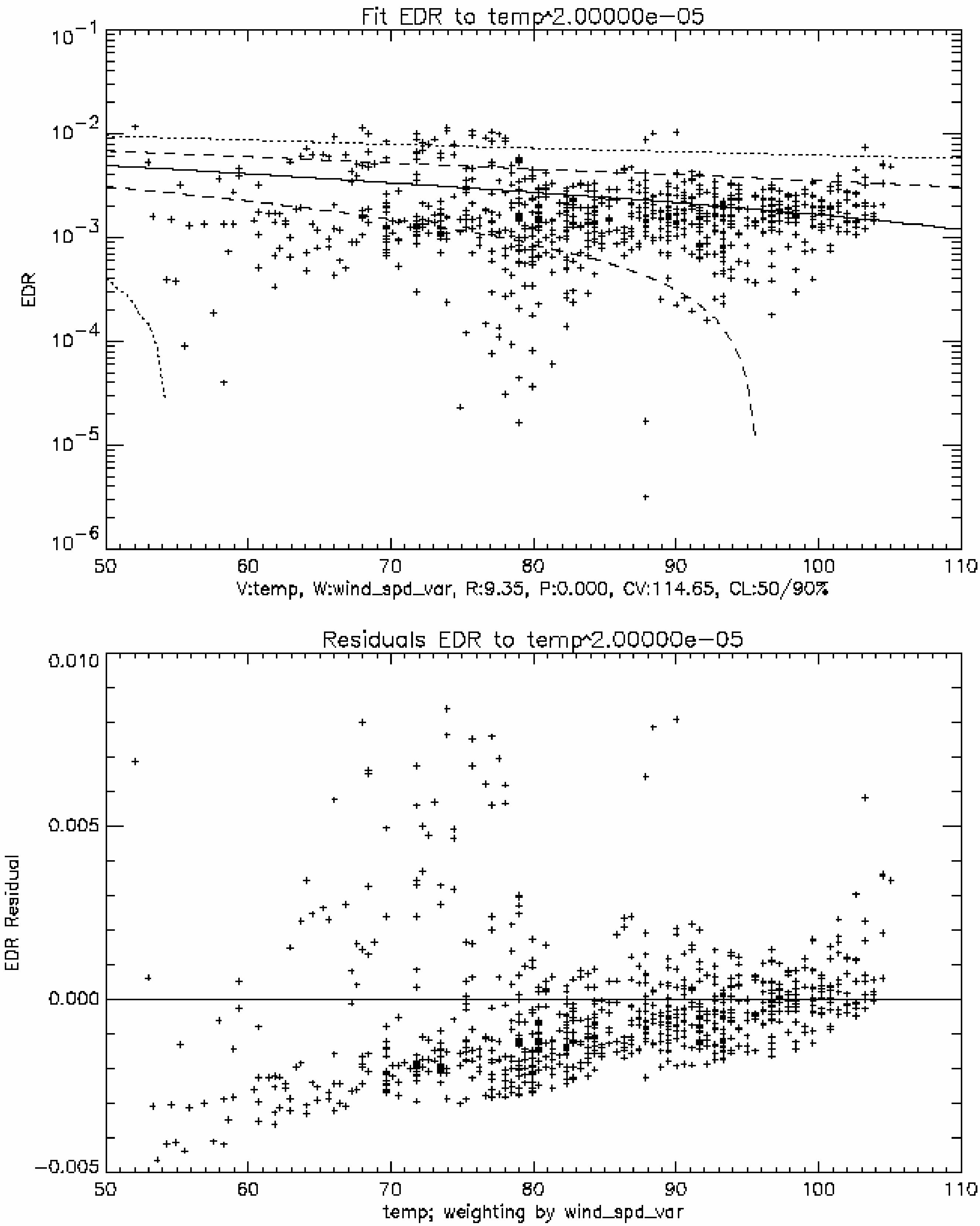


Figure 42. Opt power temp regression and residual for day model .

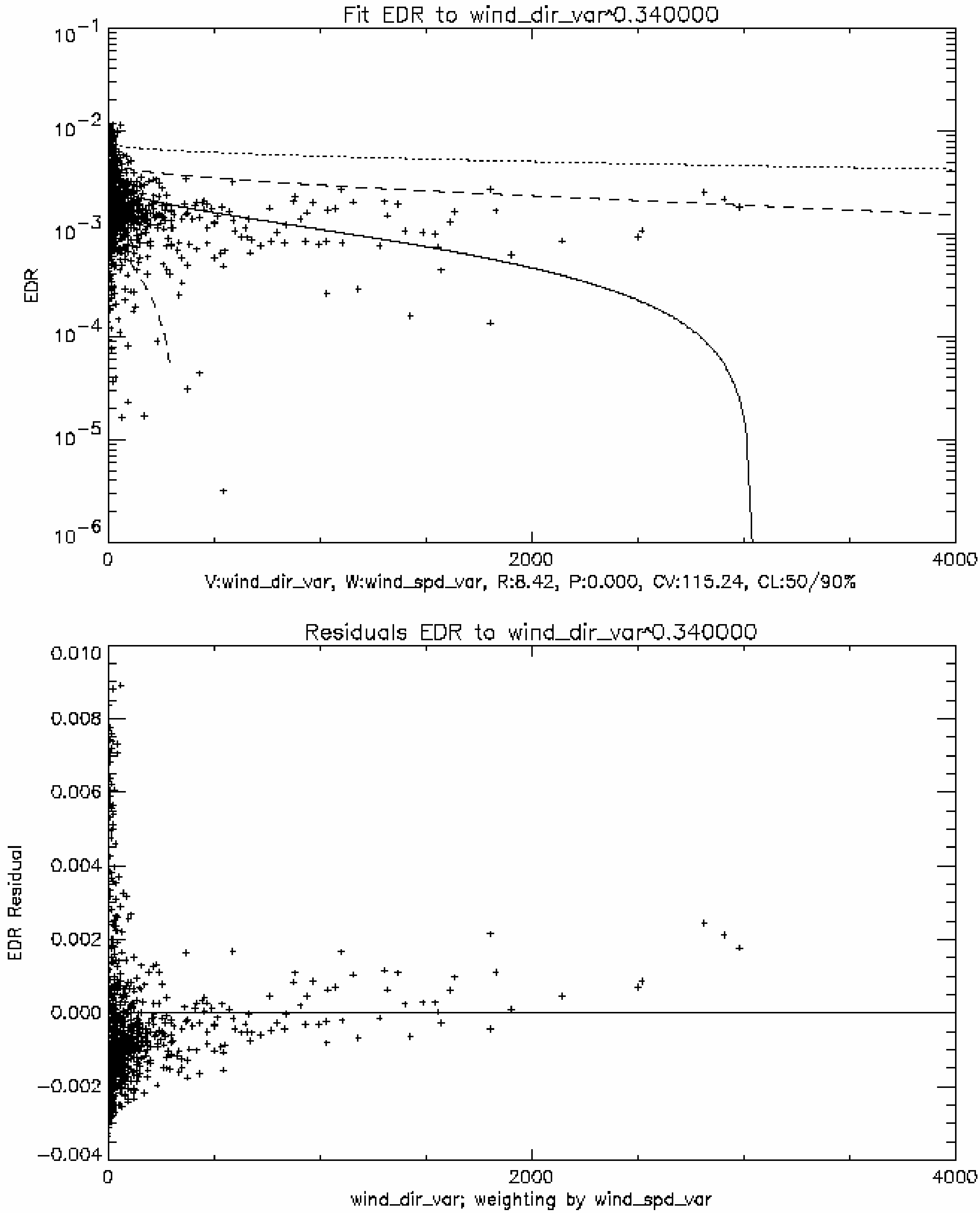


Figure 43. Opt power wind_dir_var regression and residual for day model.

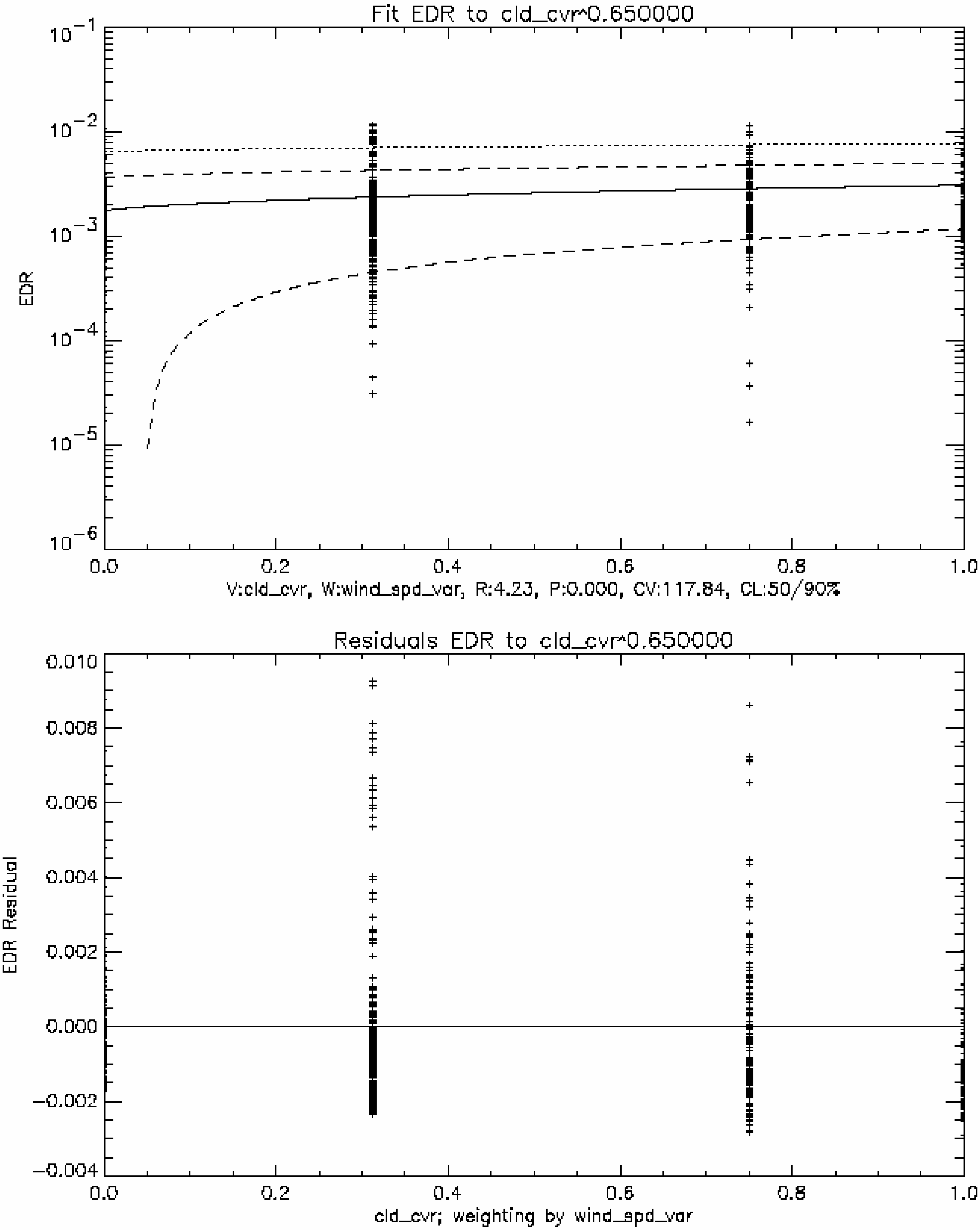


Figure 44. Opt power cld_cvr regression and residual for day model.

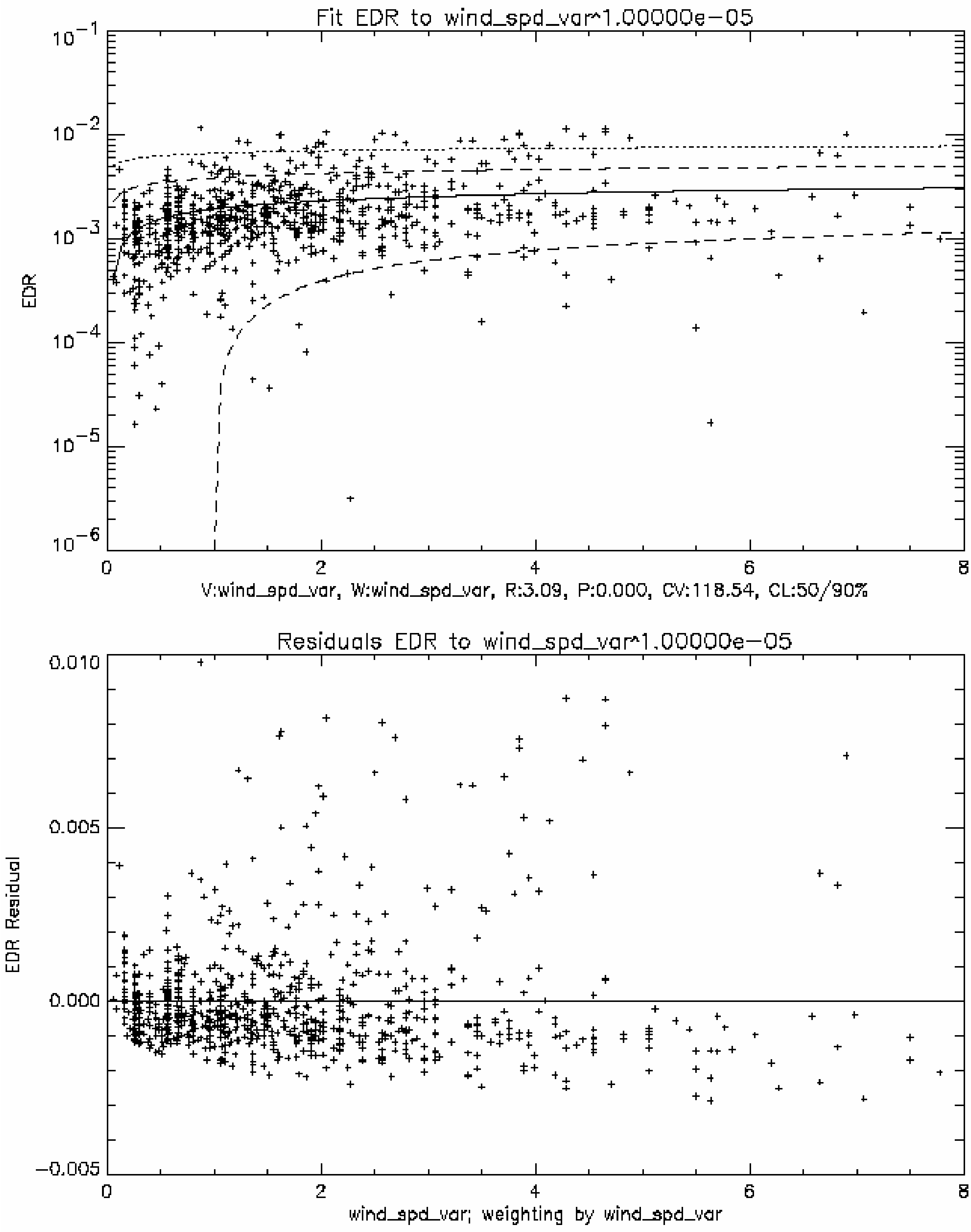


Figure 45. Opt power wind_spd_var regression and residual for day model.

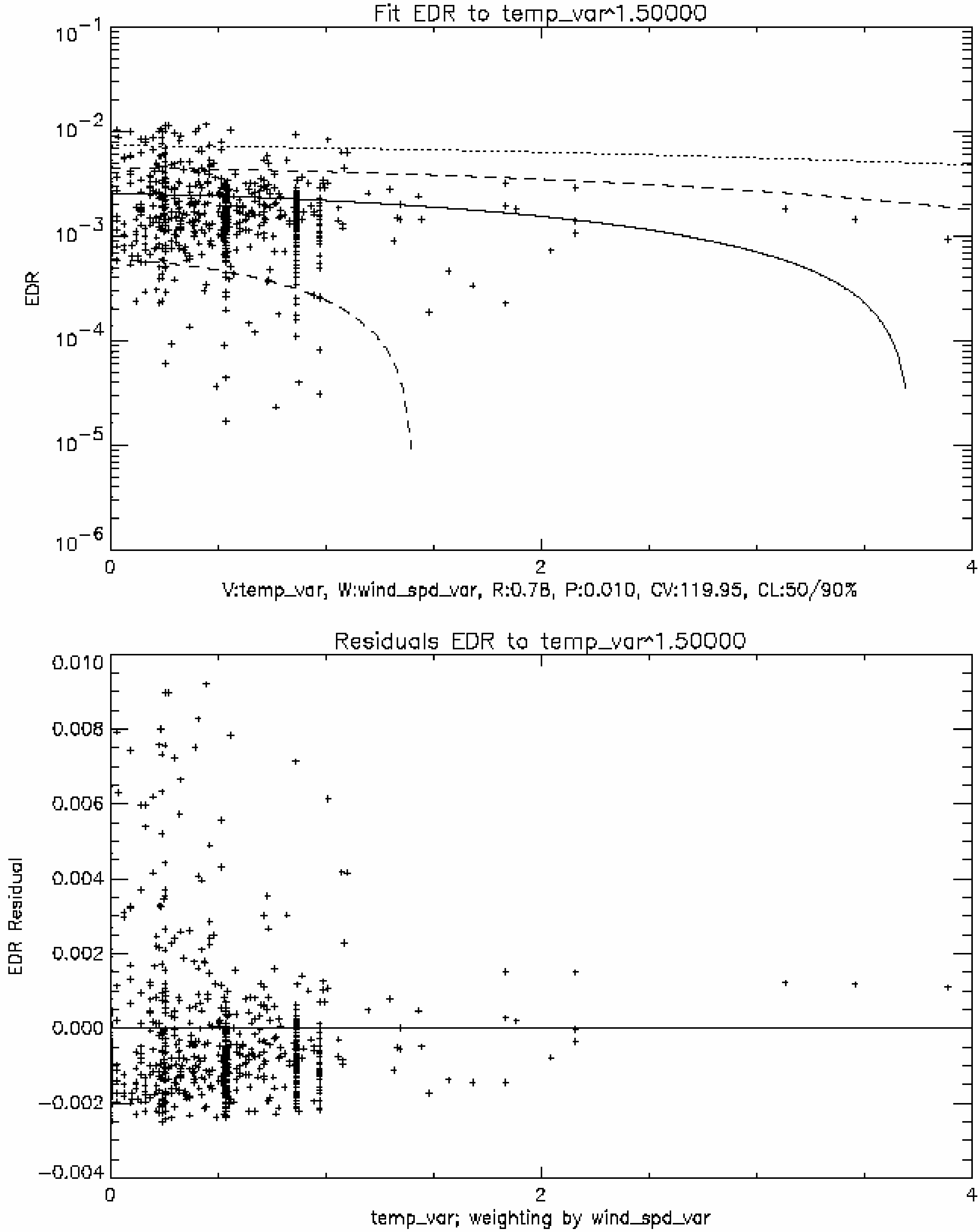


Figure 46. Opt power temp_var regression and residual for day model.

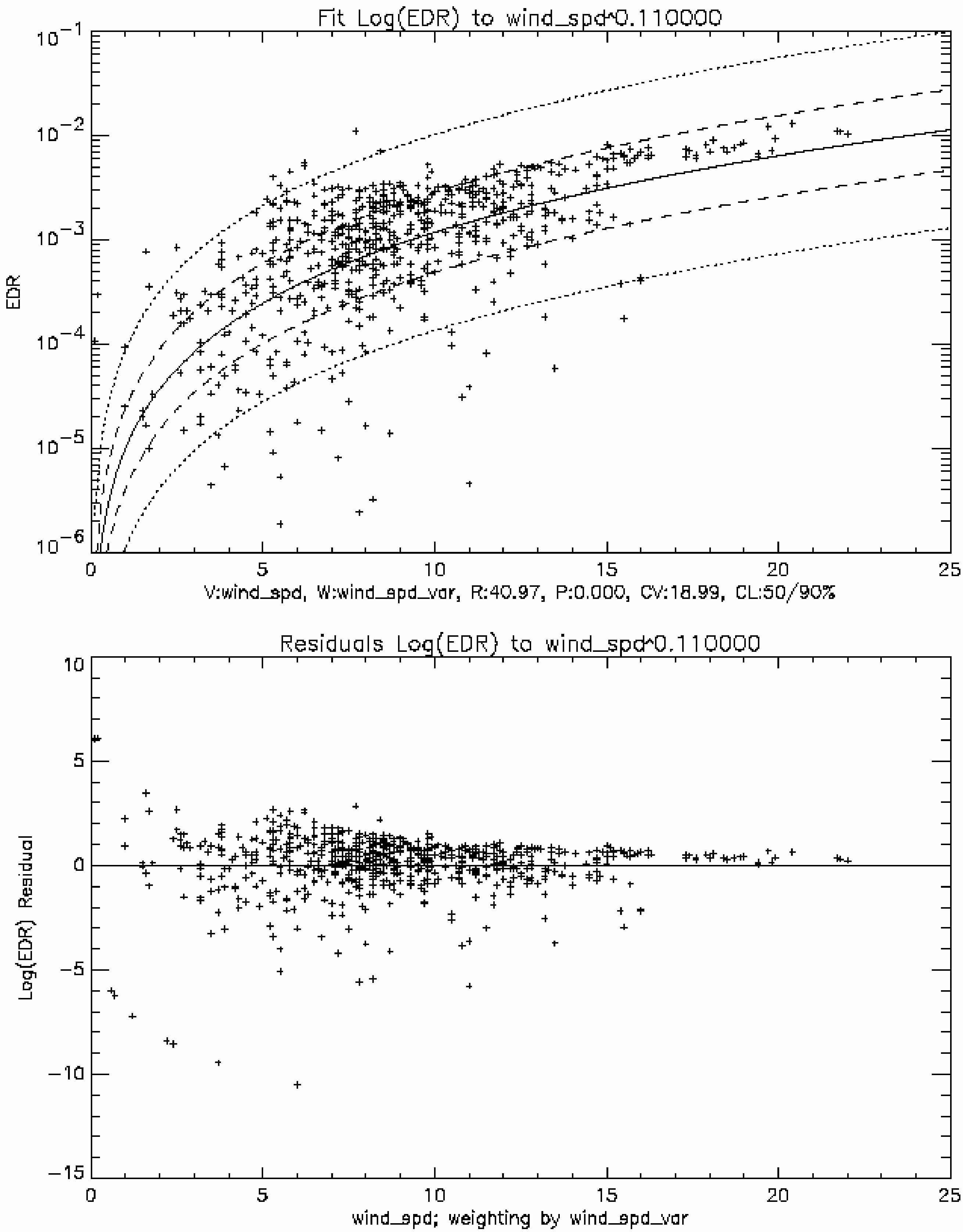


Figure 47. Opt power wind_spd regression and residual for night model.

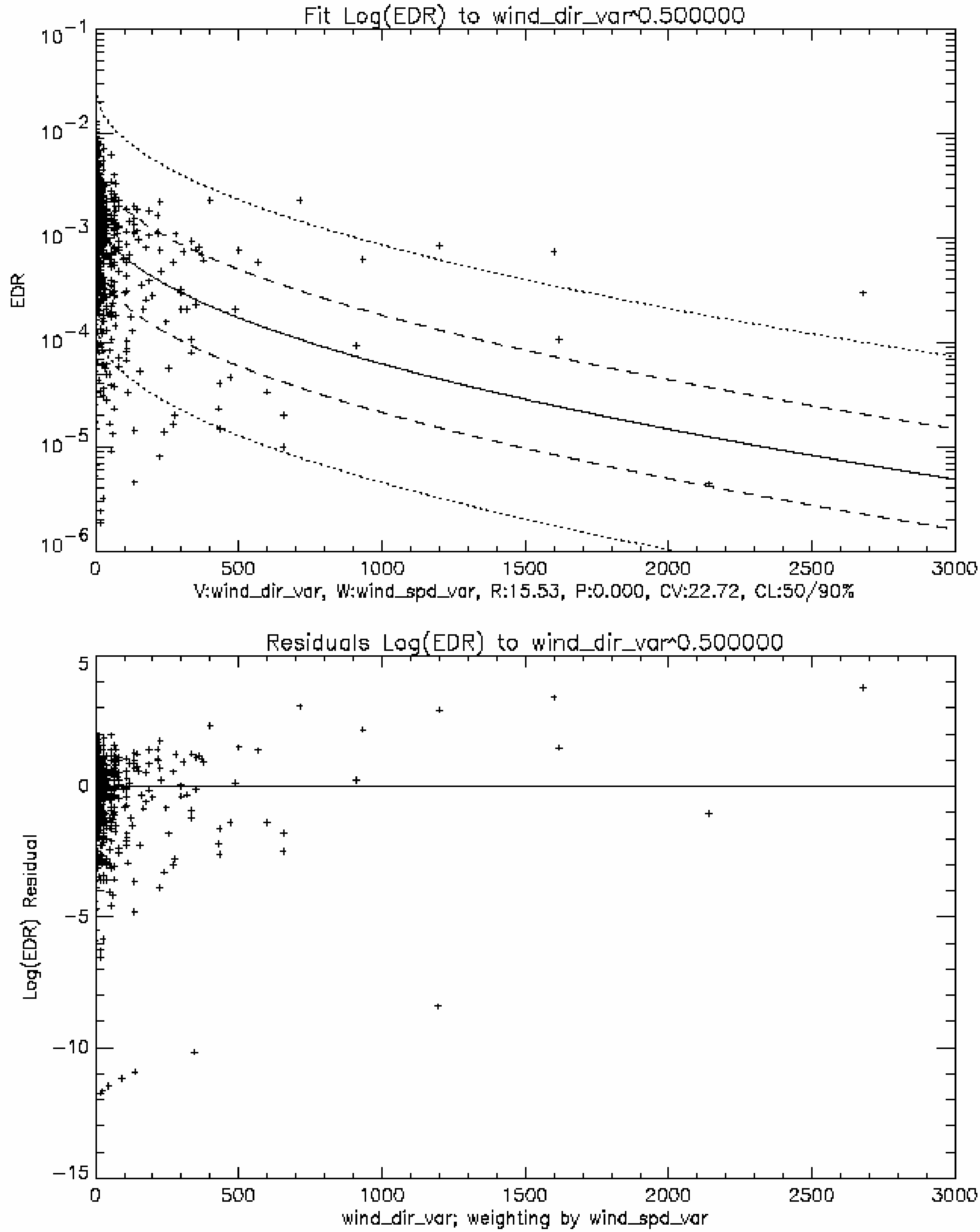


Figure 48. Opt power wind_dir_var regression and residual for night model.

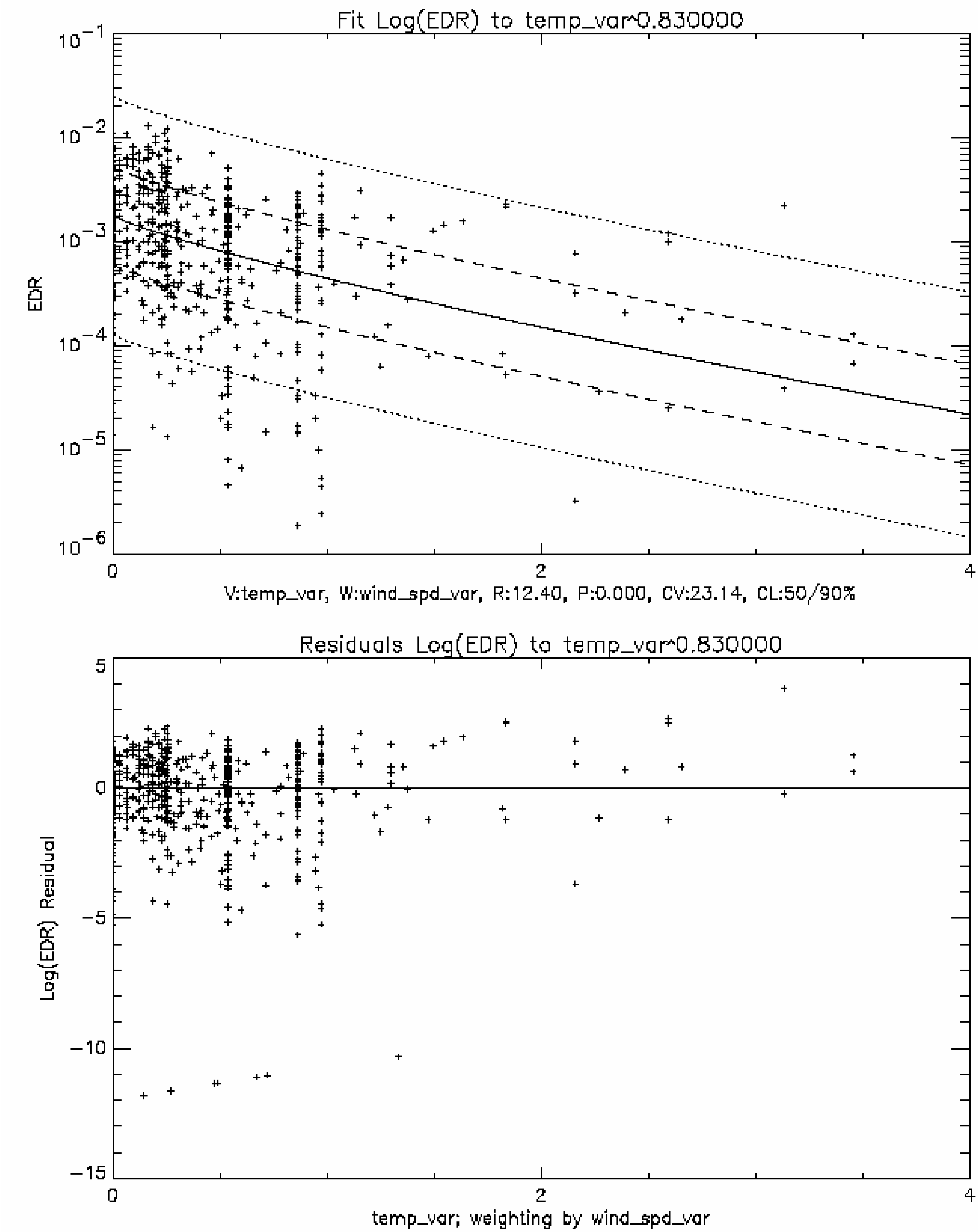


Figure 49. Opt power temp_var regression and residual for night model.

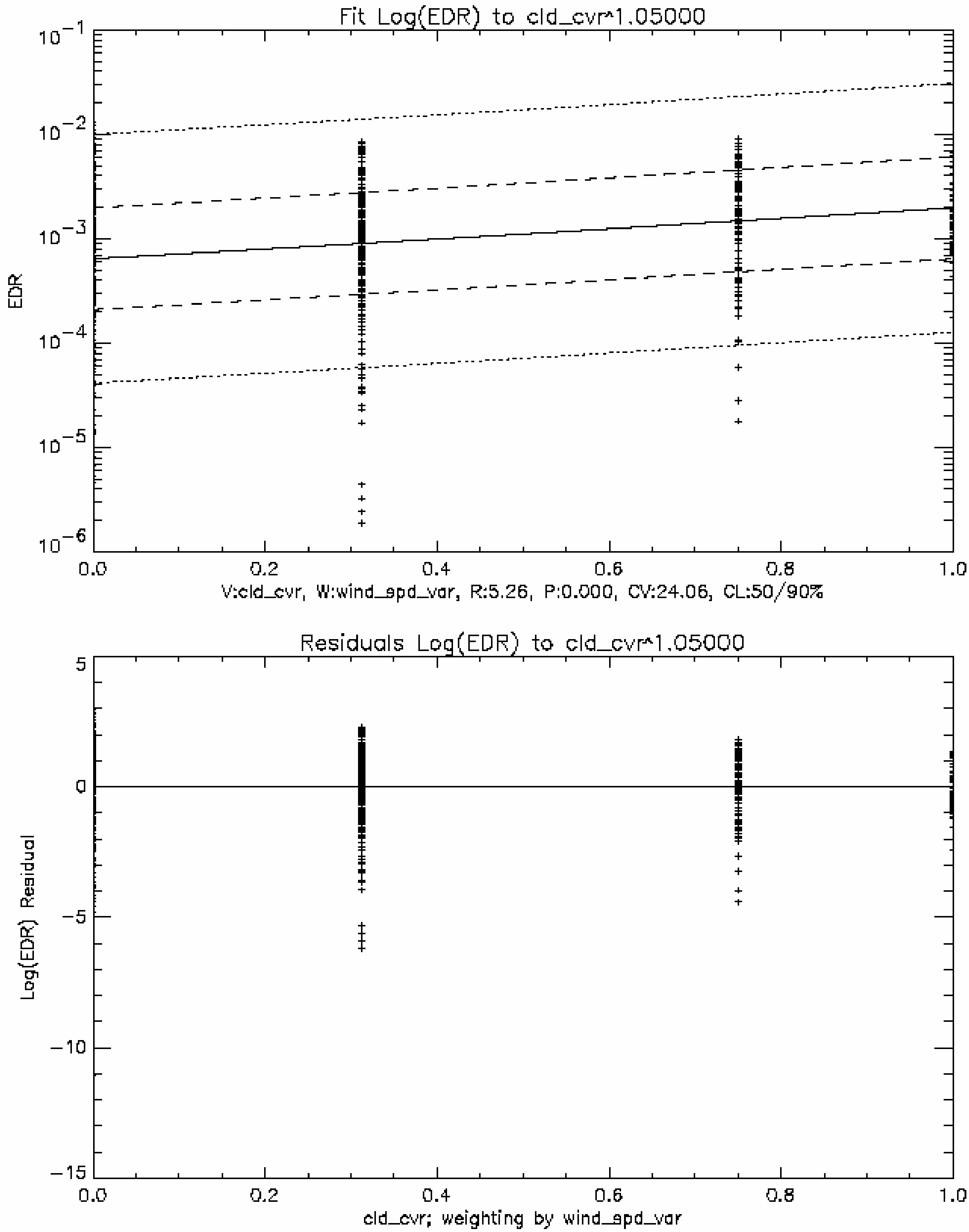


Figure 50. Opt power cld_cvr regression and residual for night model.

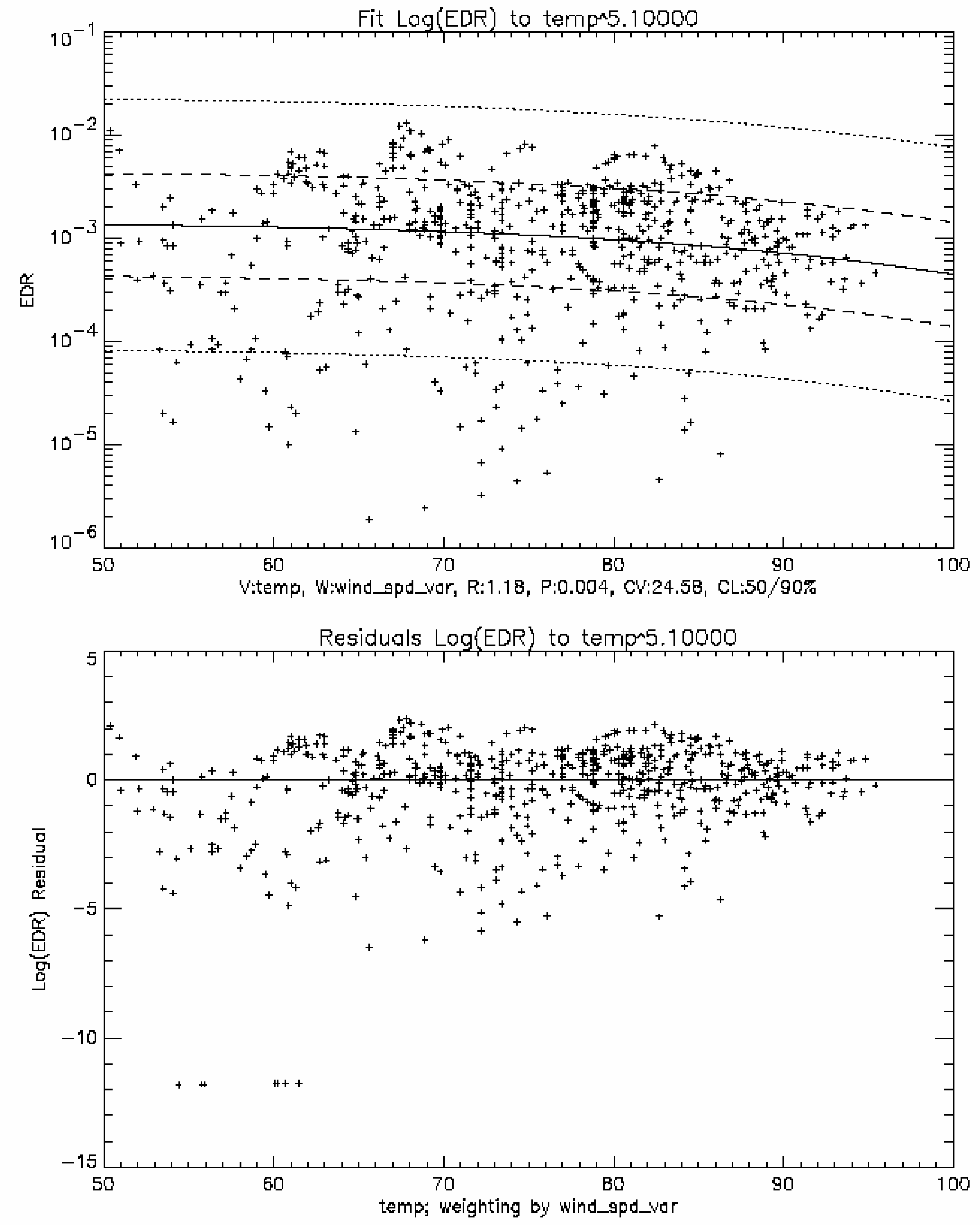


Figure 51. Opt power temp regression and residual for night model.

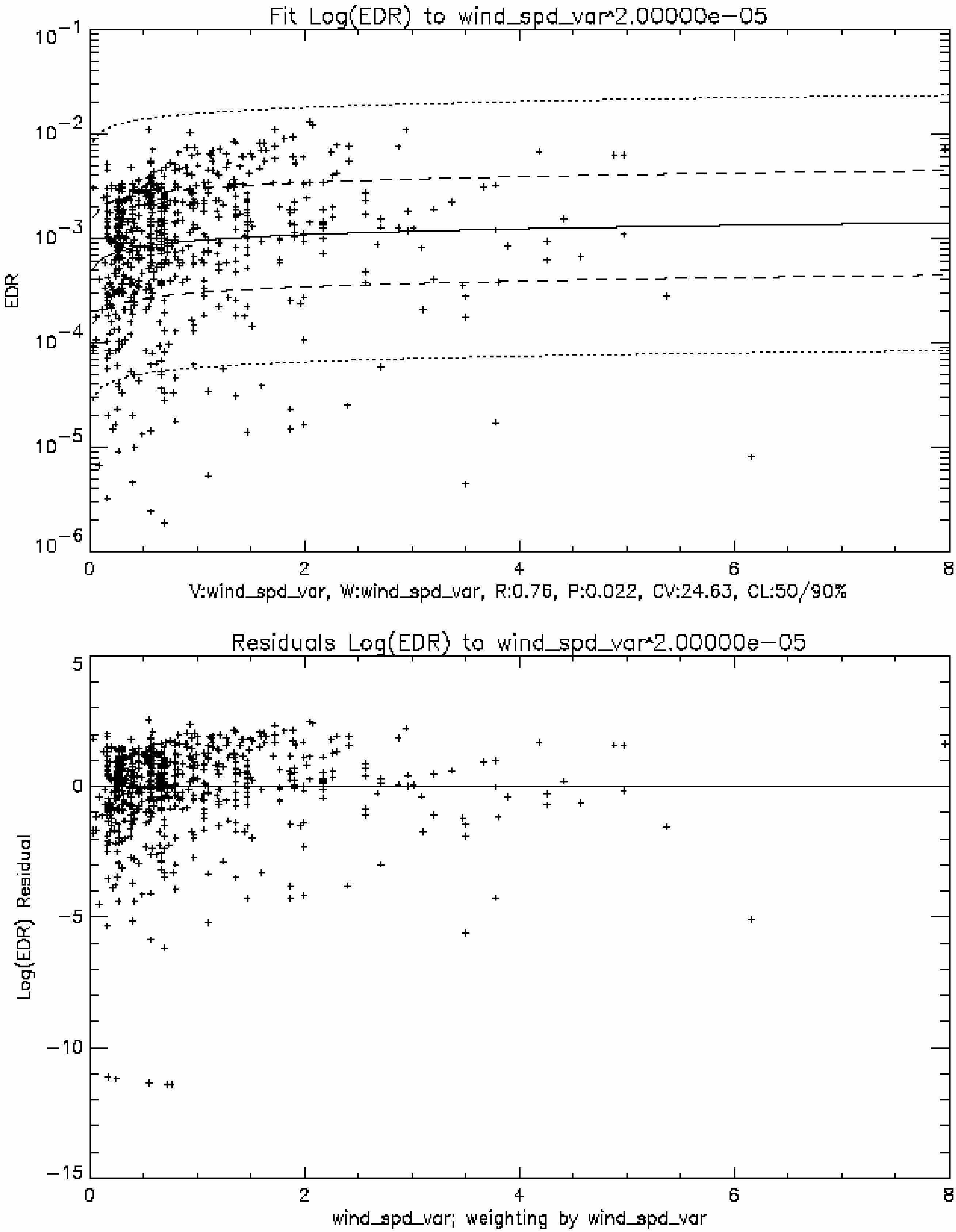
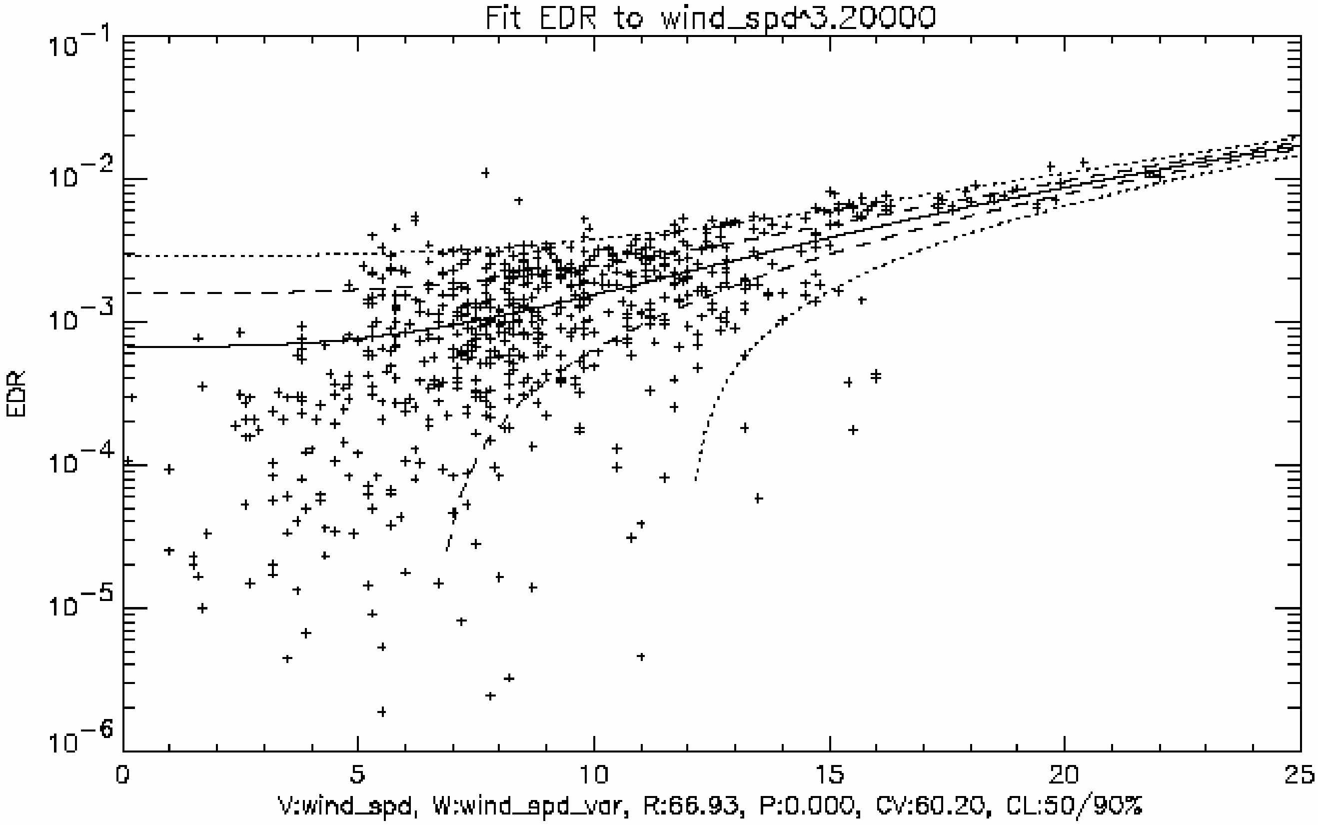


Figure 52. Opt power wind_spd_var regression and residual for night model.



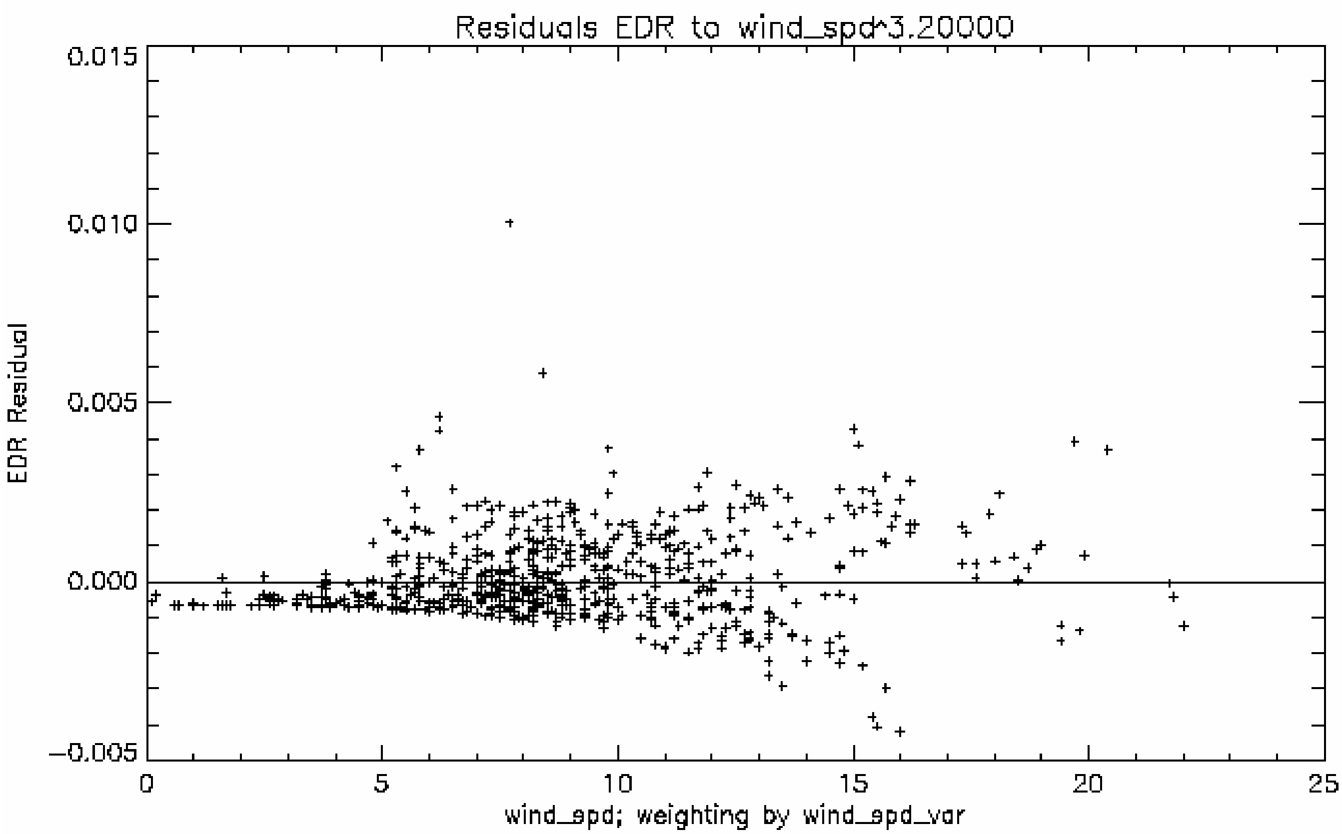
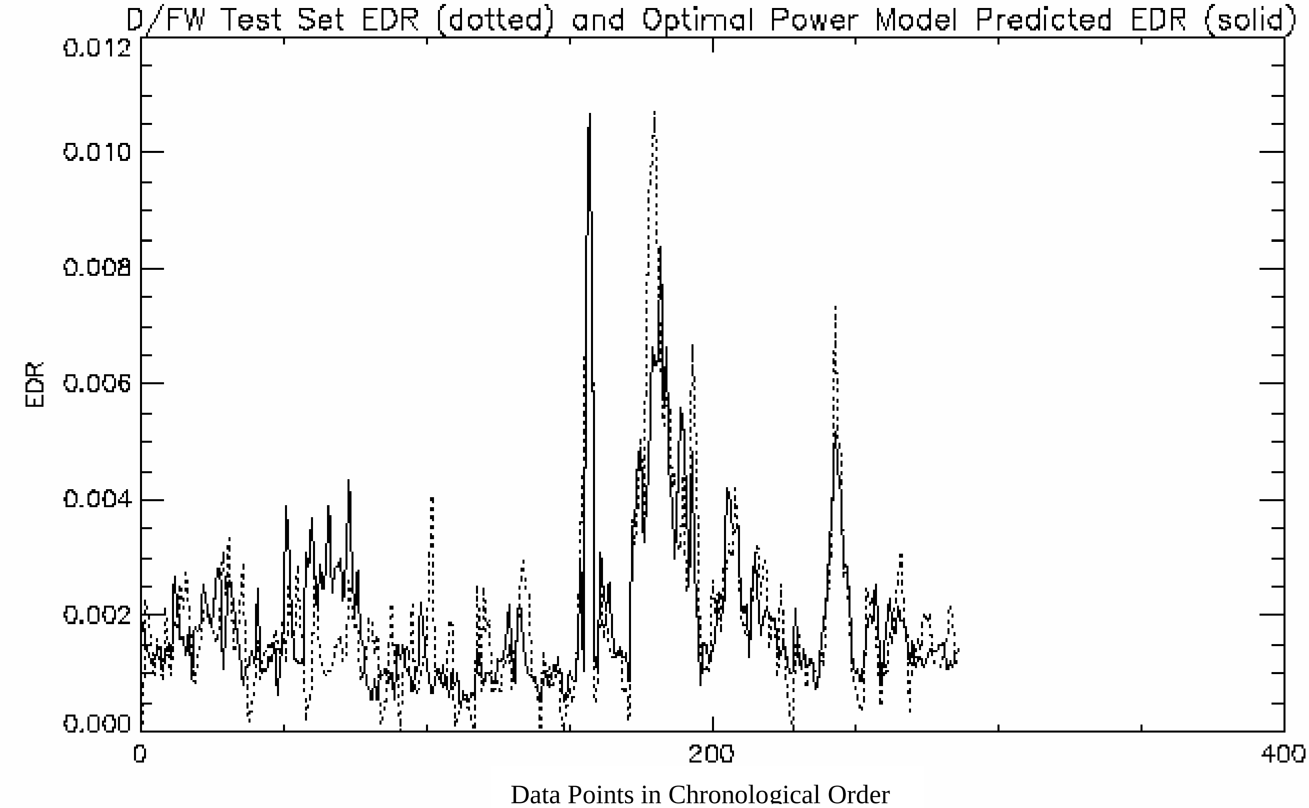


Figure 53. Opt power wind_spd regression and residual for alternative night model.



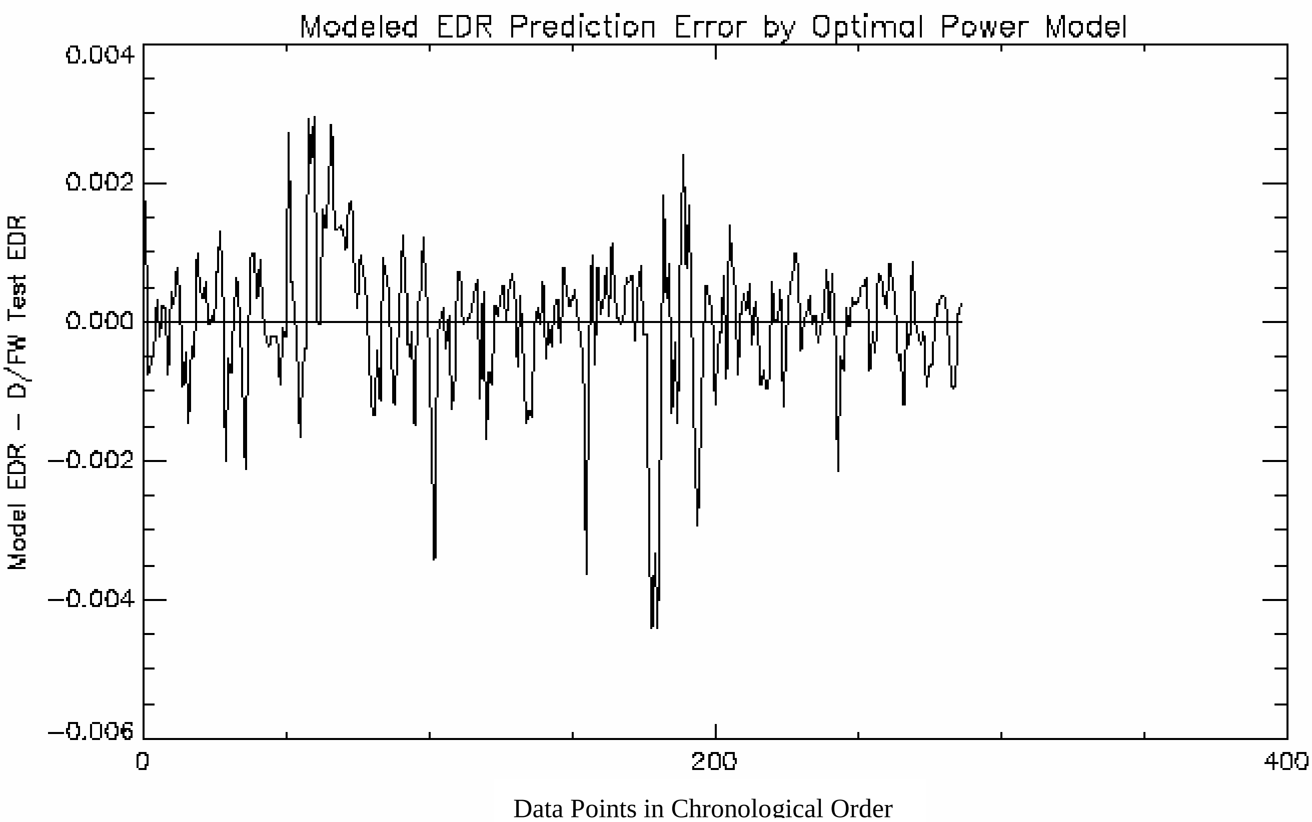
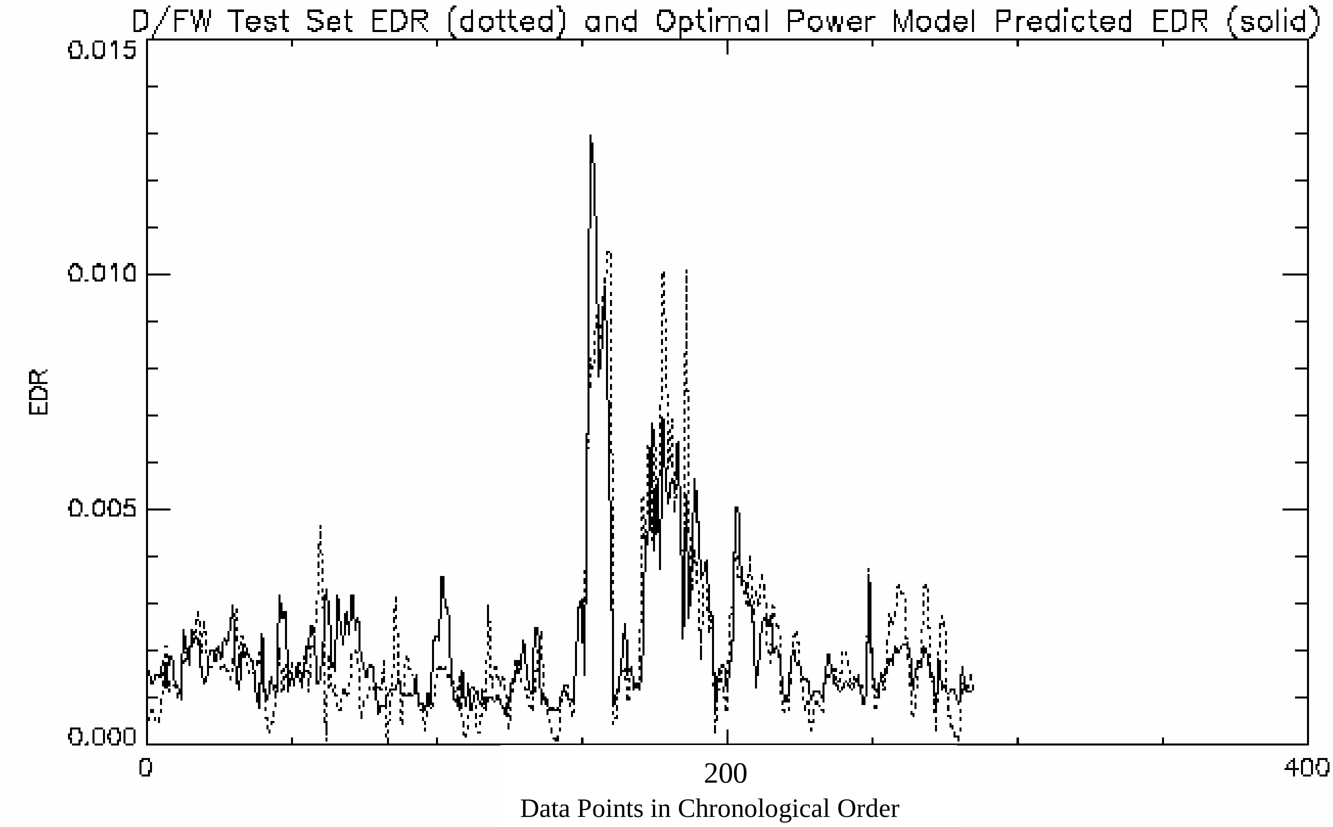


Figure 54. EDR˜ vs EDR and PE plots for $M_{wsv}[DFW_d^1:all]$ on DFW_{d1}.



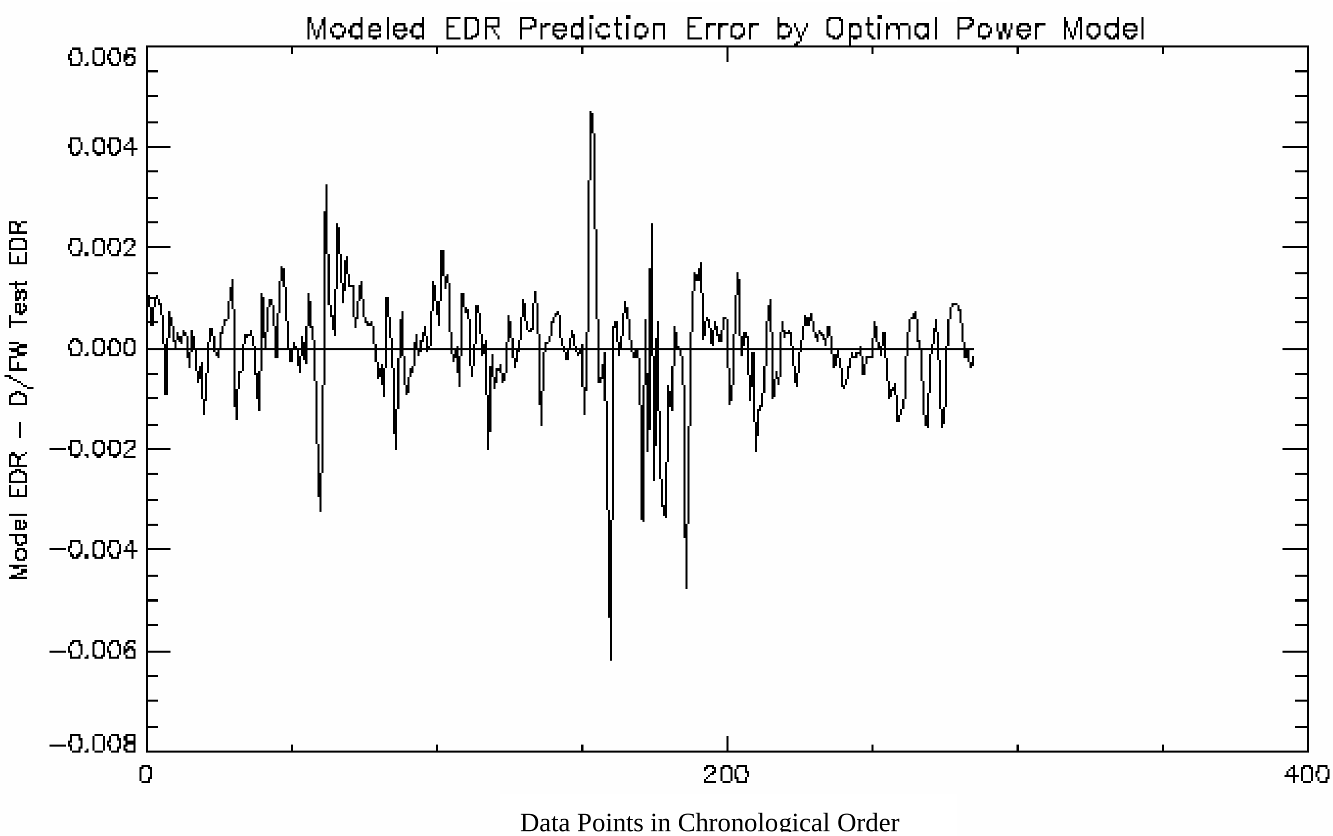
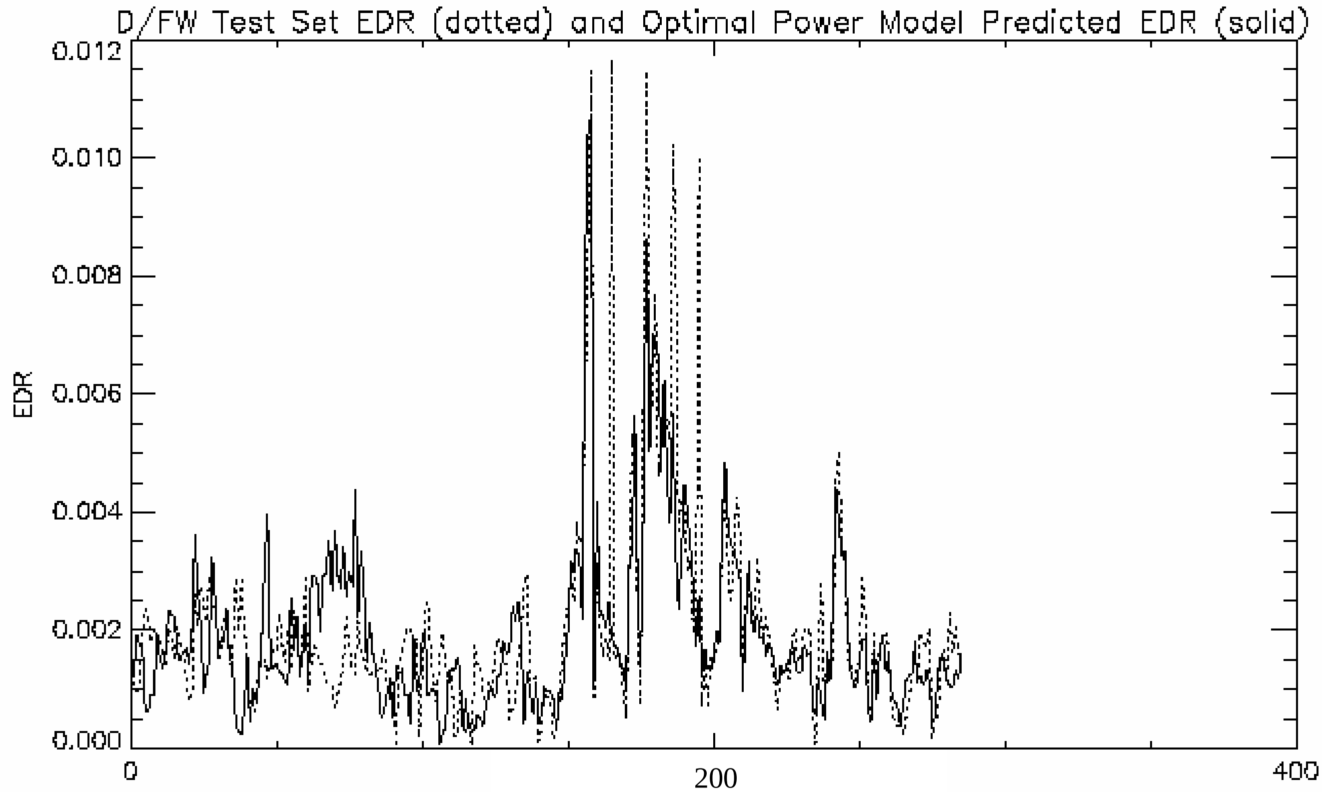
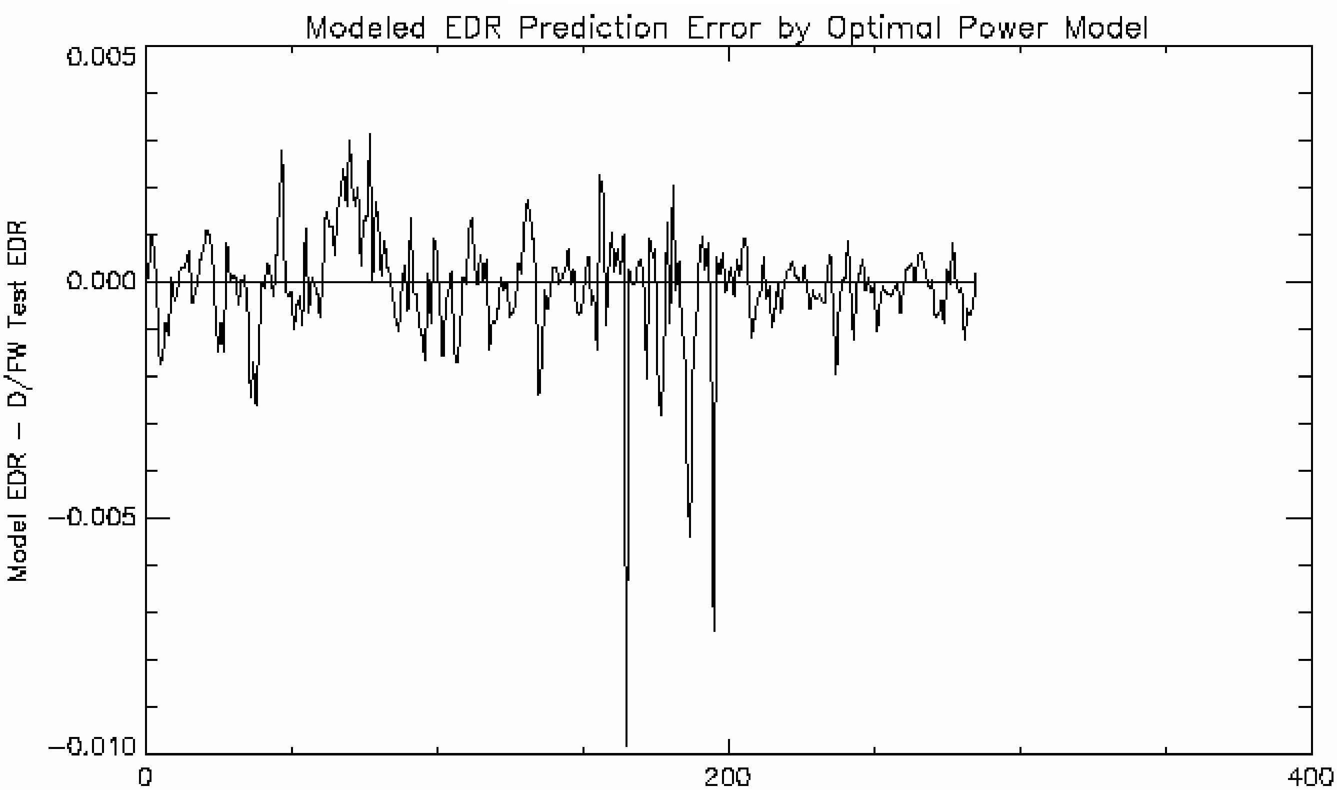


Figure 55. EDR˜ vs EDR and PE plots for $M_{wsv}[DFW_d^2{:}all]$ on DFW_{d2}.



200

Data Points in Chronological Order



Data Points in Chronological Order

Figure 56. EDR˜ vs EDR and PE plots for $M_{wsv}[DFW_d^3\text{:all}]$ on DFW_{d3}.

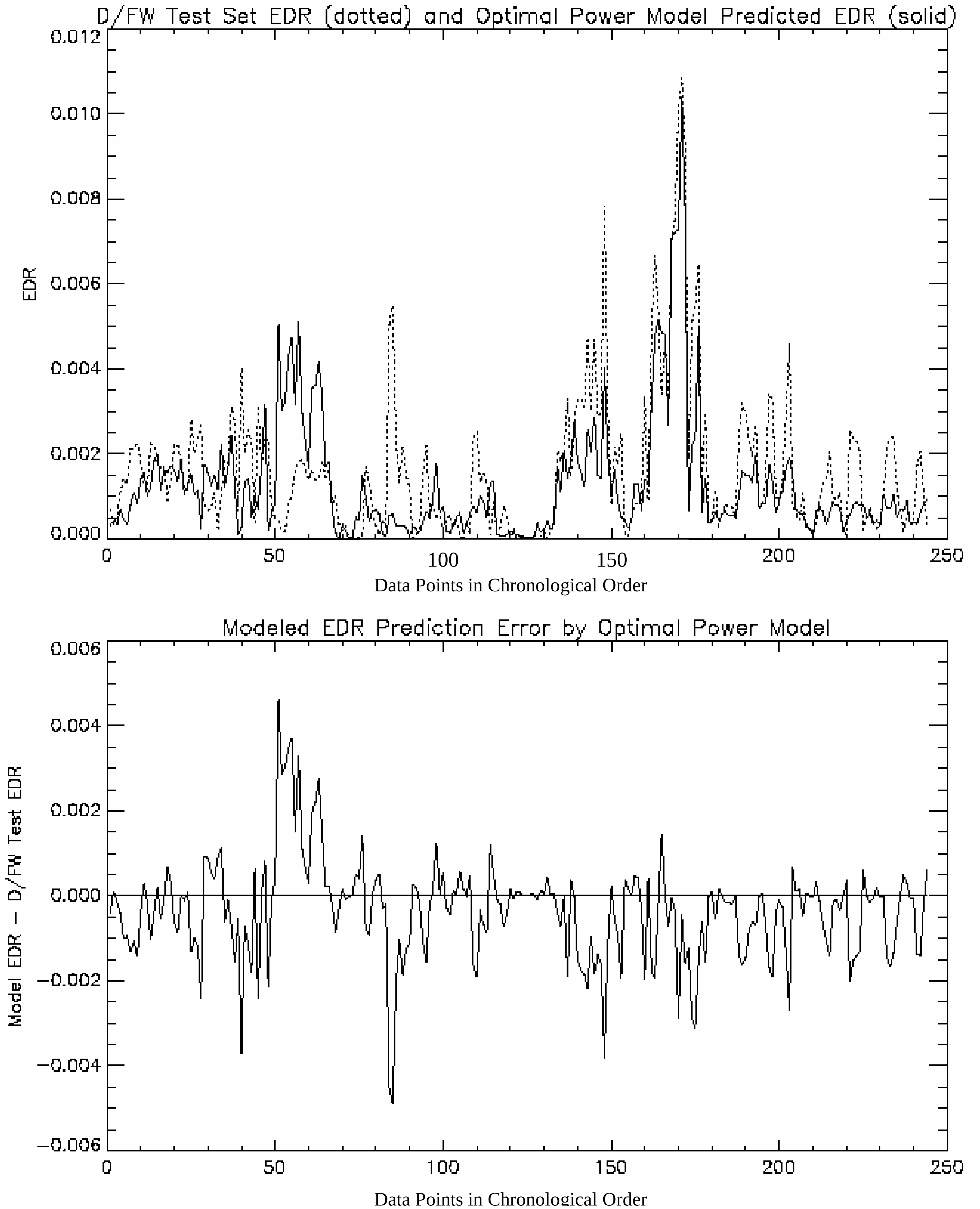


Figure 57. EDR˜ vs EDR and PE plots for $\ln M_{wsv}[DFW_n^1\text{:all}]$ on DFW_{n1}.

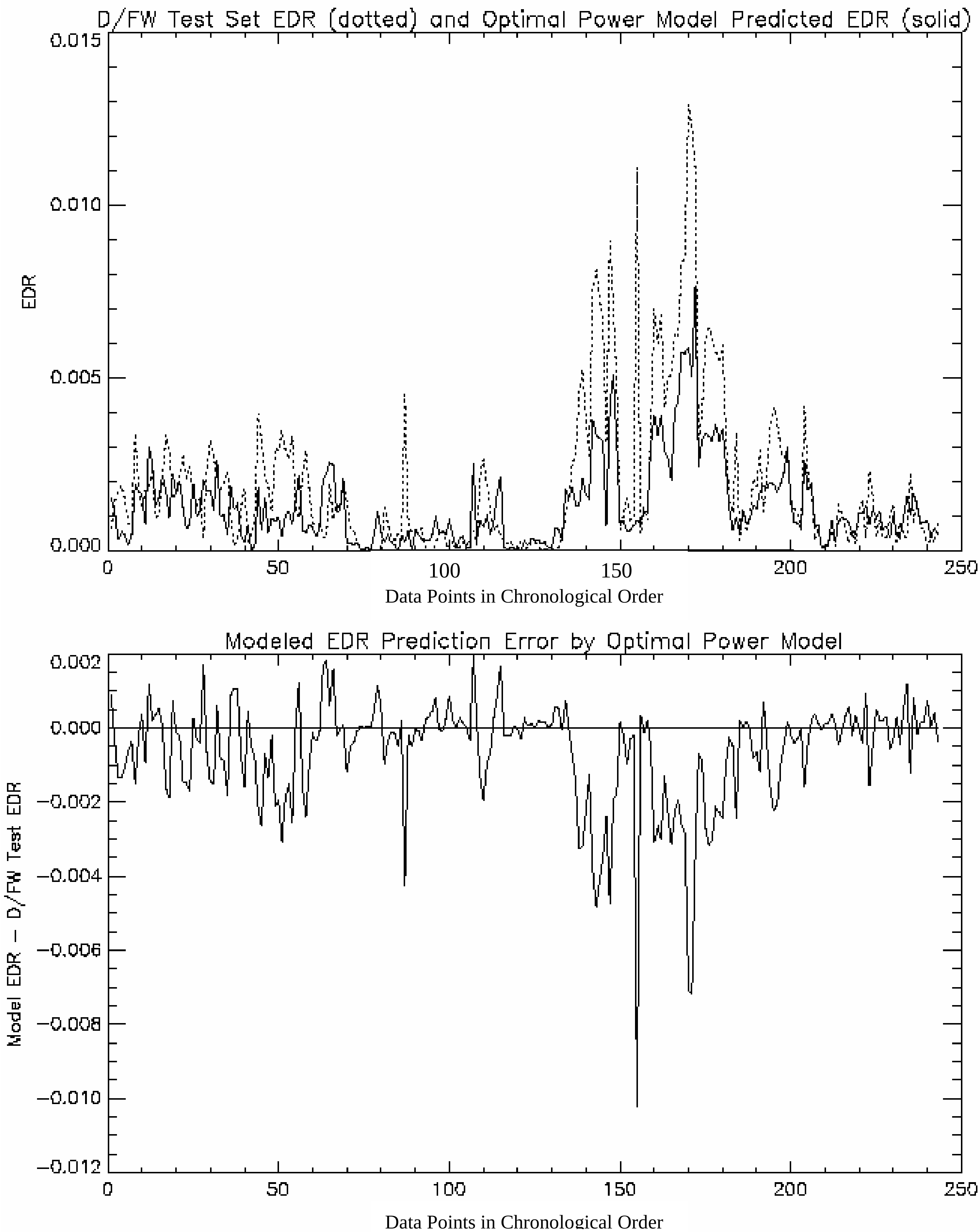


Figure 58. EDR˜ vs EDR and PE plots for $\ln M_{wsv}[DFW_n^2{:}all]$ on DFW_{n2}.

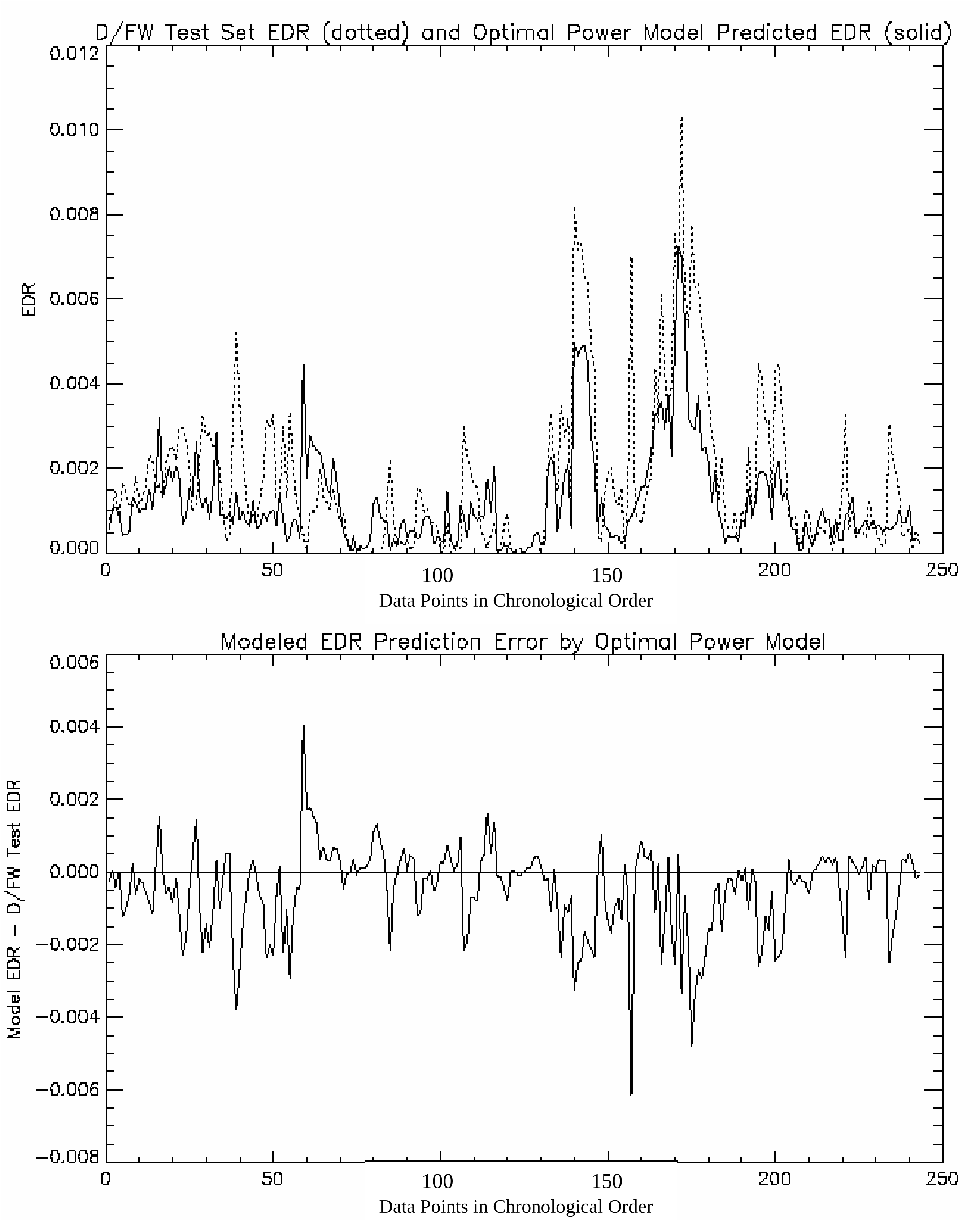


Figure 59. EDR˜ vs EDR and PE plots for $\ln M_{wsv}[DFW_n^3\text{:all}]$ on DFW_{n3}.

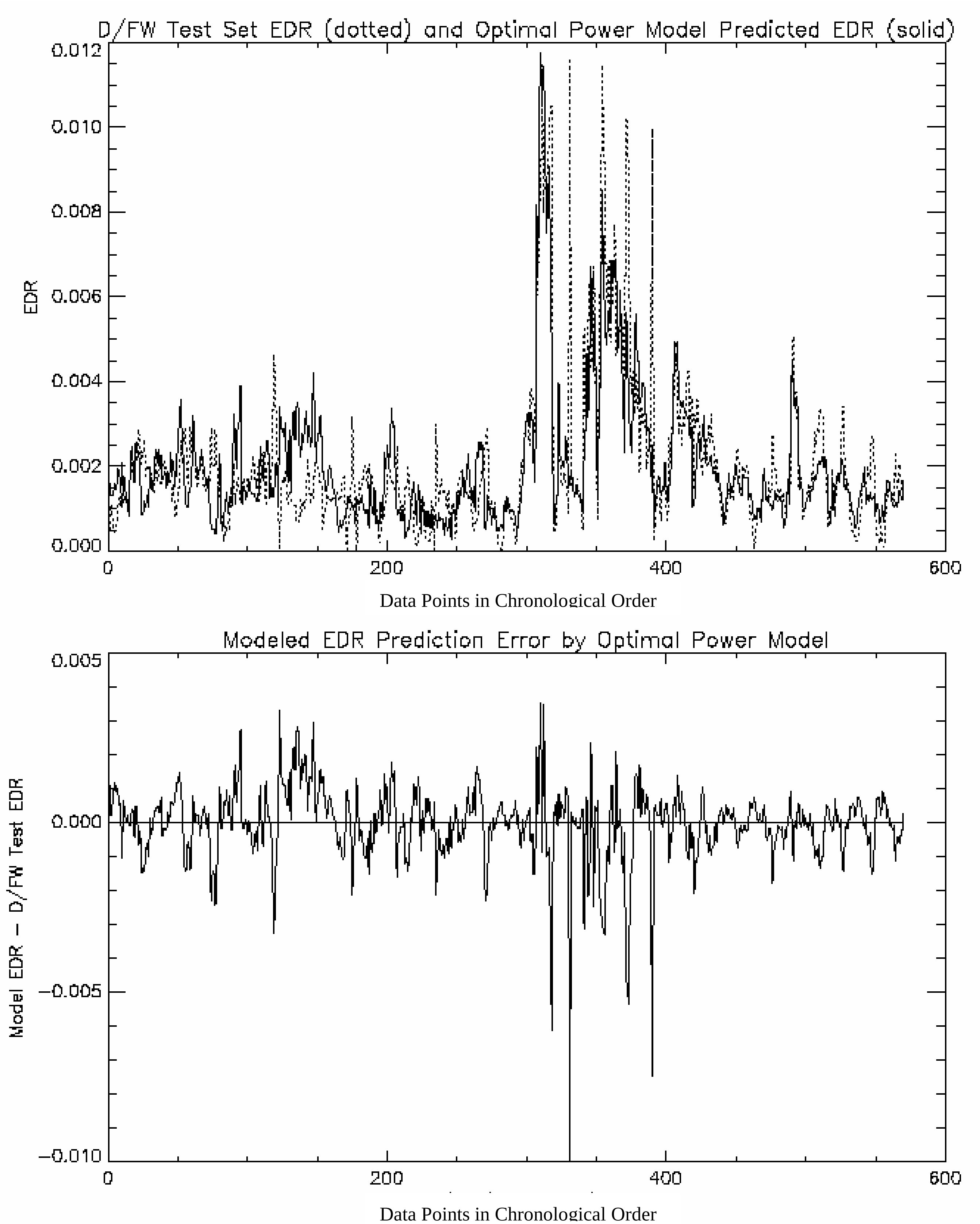


Figure 60. EDR˜ vs EDR and PE plots for $M_{wsv}[DFW_d^1{:}all]$ on DFW_d^1.

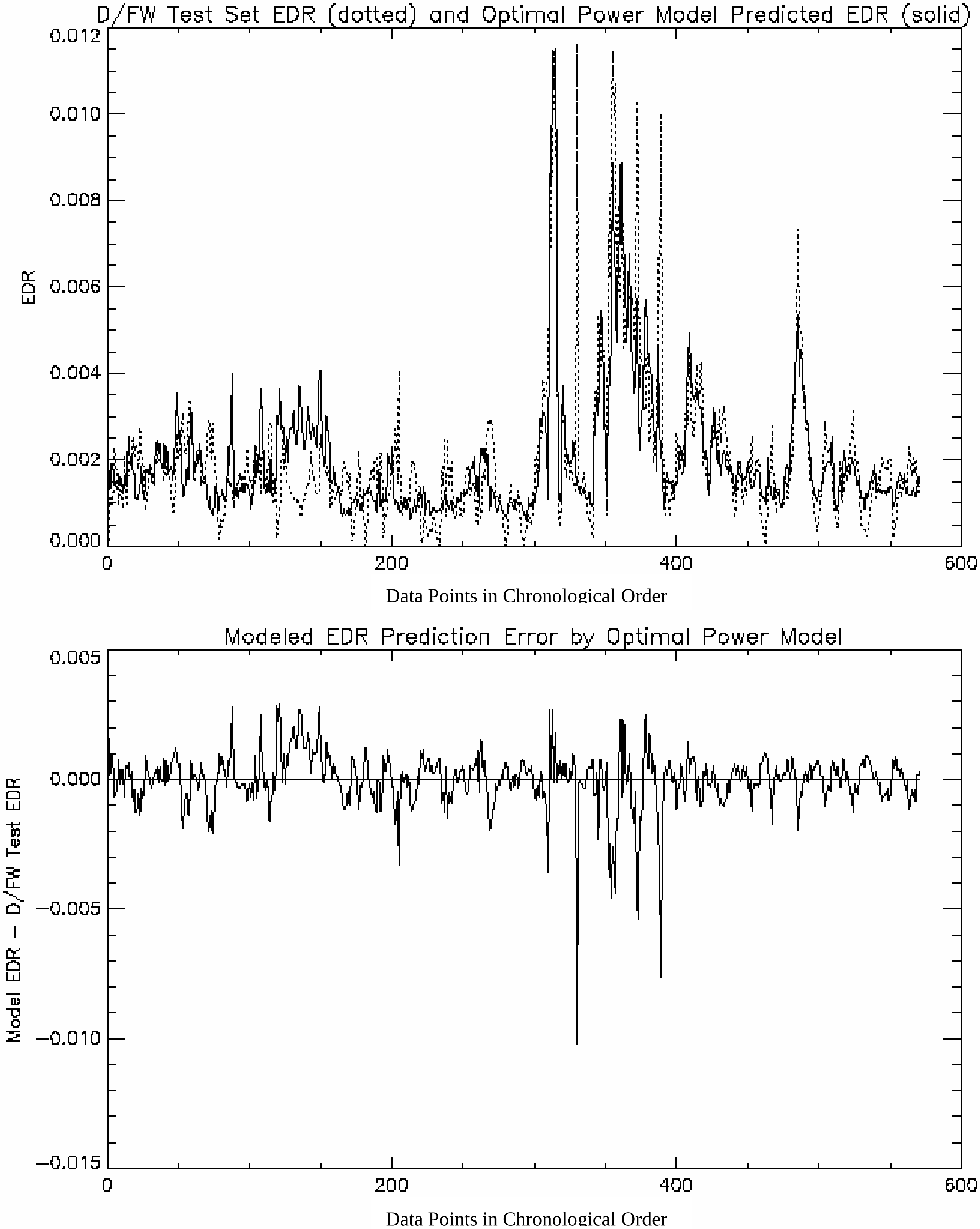


Figure 61. $\tilde{EDR}$ vs EDR and PE plots for $M_{wsv}[DFW_d^2\text{:all}]$ on DFW_d^2.

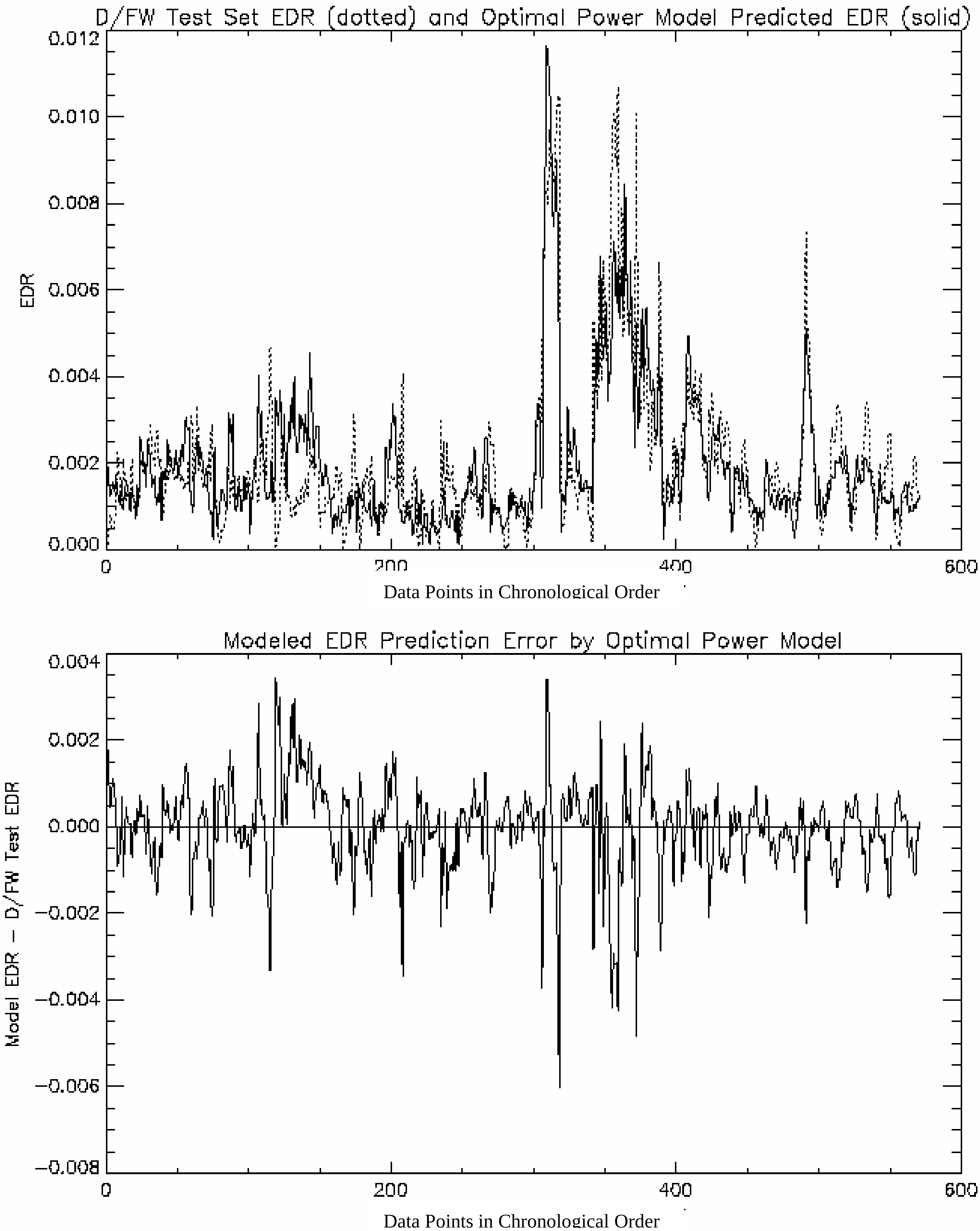


Figure 62. EDR˜ vs EDR and PE plots for $M_{wsv}[DFW_d^3:all]$ on DFW_d^3.

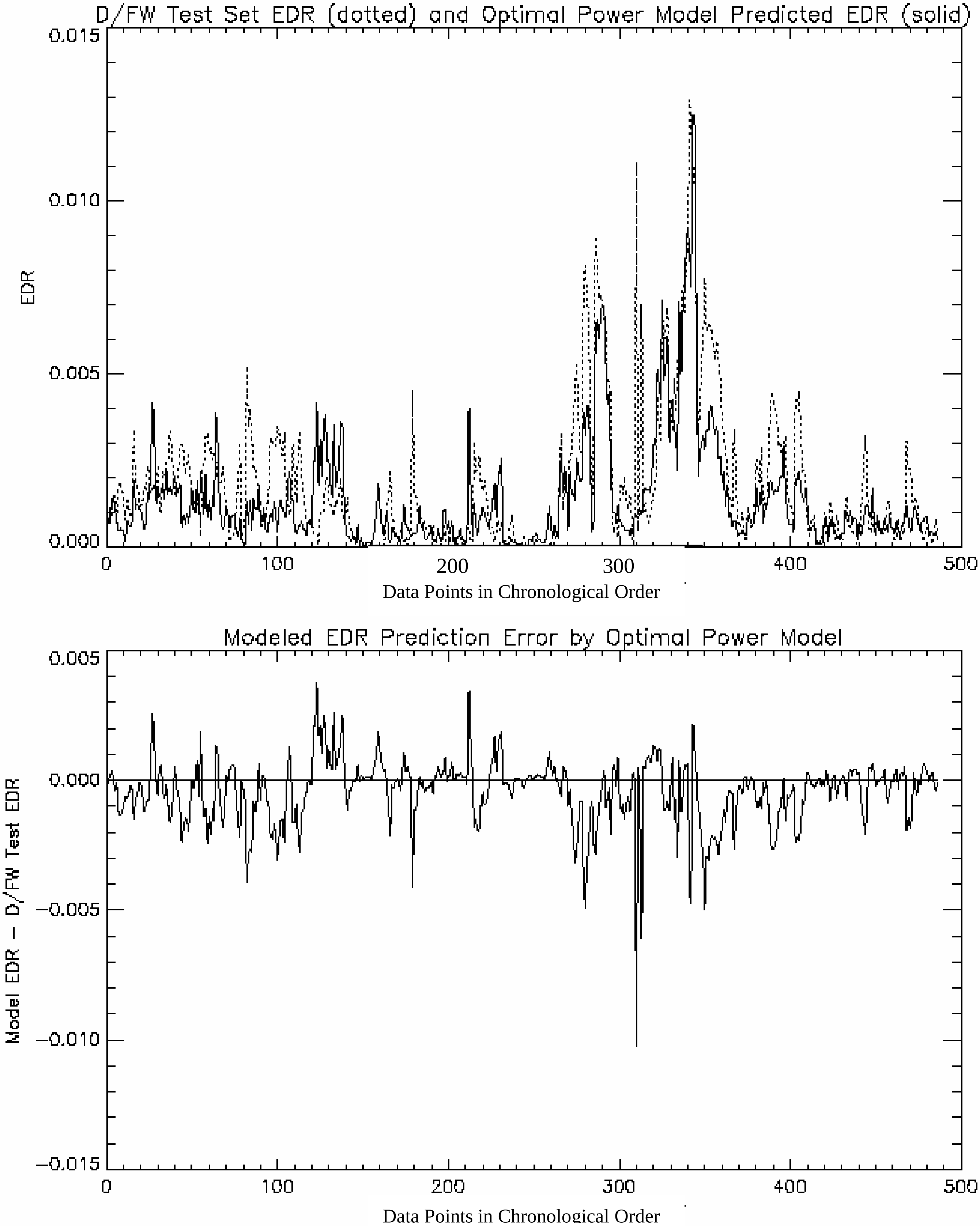
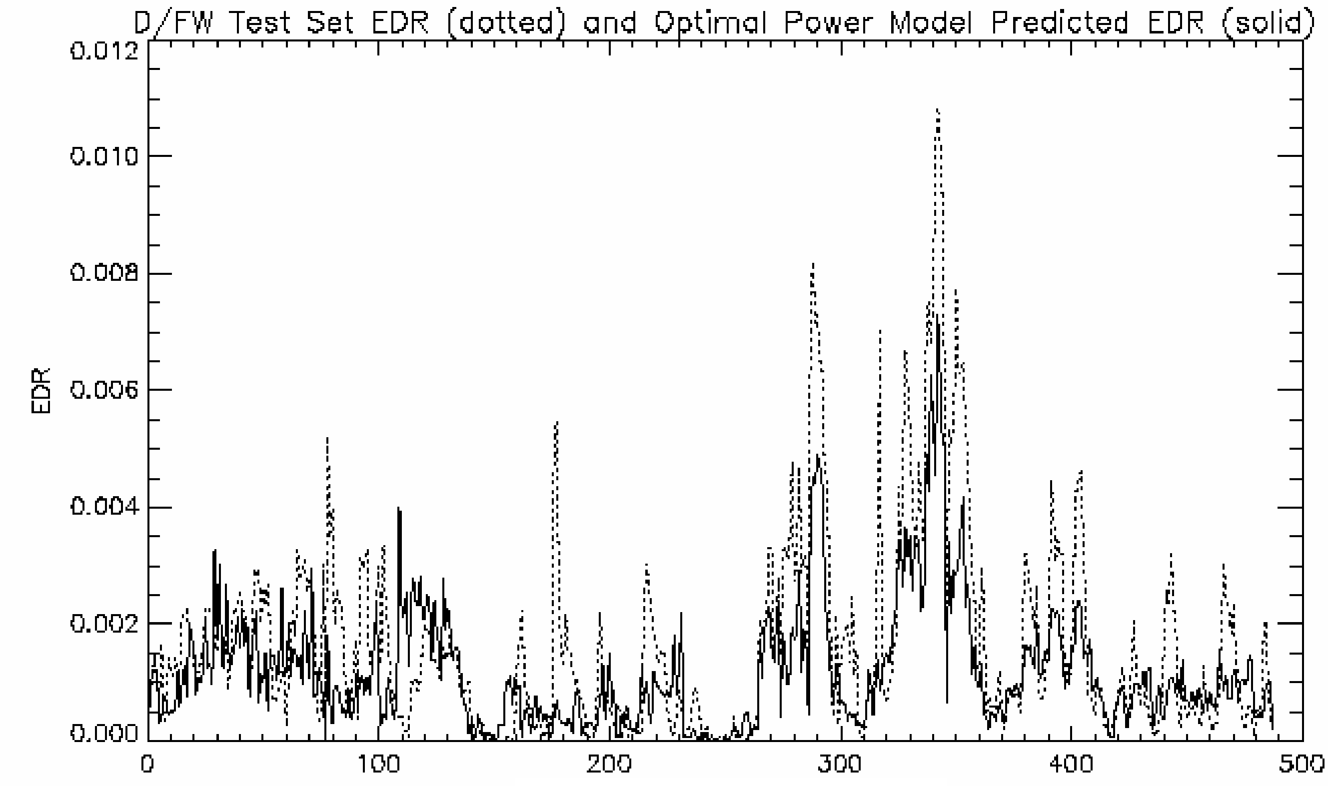
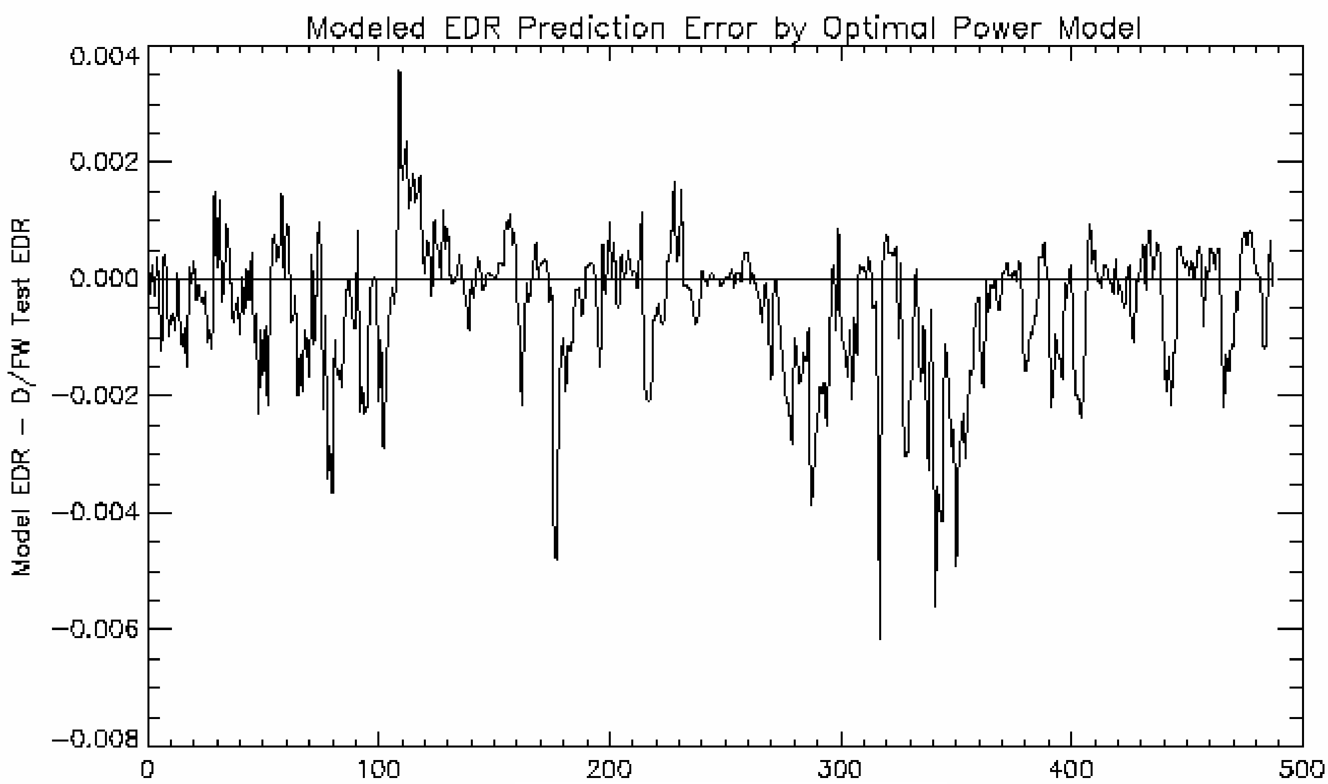


Figure 63. $\tilde{EDR}$ vs EDR and PE plots for $\ln M_{wsv}[DFW_n^1\text{:all}]$ on DFW_n^1.



Data Points in Chronological Order



Data Points in Chronological Order

Figure 64. EDR$^{\sim}$ vs EDR and PE plots for $\ln M_{wsv}[DFW_n^2{:}all]$ on DFW_n^2.

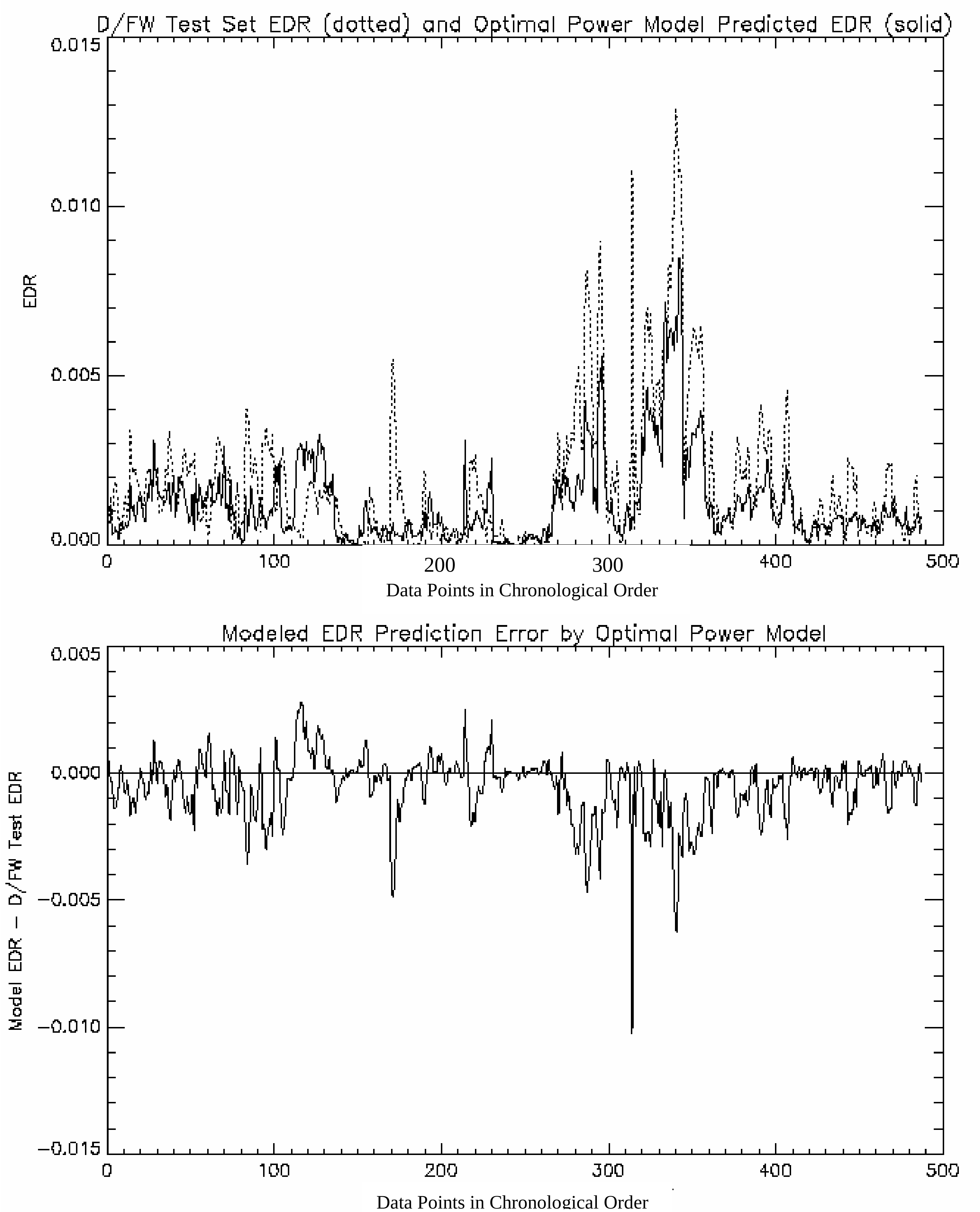


Figure 65. EDR˜ vs EDR and PE plots for $\ln M_{wsv}[DFW_n^3\text{:all}]$ on DFW_n^3.

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14. ABSTRACT
Linear multivariable regression models for predicting day and night Eddy Dissipation Rate (EDR) from available meteorological data sources are defined and validated. Model definition is based on a combination of 1997-2000 Dallas/Fort Worth (DFW) data sources, EDR from Aircraft Vortex Spacing System (AVOSS) deployment data, and regression variables primarily from corresponding Automated Surface Observation System (ASOS) data. Model validation is accomplished through EDR predictions on a similar combination of 1994-1995 Memphis (MEM) AVOSS and ASOS data. Model forms include an intercept plus a single term of fixed optimal power for each of these regression variables; 30-minute forward averaged mean and variance of near-surface wind speed and temperature, variance of wind direction, and a discrete cloud cover metric. Distinct day and night models, regressing on EDR and the natural log of EDR respectively, yield best performance and avoid model discontinuity over day/night data boundaries.

15. SUBJECT TERMS
Multivariable regression; Statistical modeling; Meteorological data; Eddy dissipation rate; Wake vortex prediction

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